Original Research

Review Study Of The Application Of Nanofield Coatings In Restorative Materials With Base Glass Ionomer: Water Absorption And Solubility Of Restorative Materials

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Abstract:

Background:

Nanofilled resin-based coatings are a type of surface coating that consists of a resin matrix filled with nanoparticles, which offer several benefits over conventional resin-based coatings. Restorative materials with a base of glass ionomer have become increasingly popular in the field of dentistry over the past few decades. In this study we reviewed the application of nanofield coatings in restorative materials with base glass ionomer.

Methods:

A narrative review.

Results and Conclusion:

There are limited research on impact of nanofield coatings on the water absorption and solubility of restorative materials with a base of glass ionomer, available studies suggest that such coatings may help improve water resistance and durability of these materials. The study by Jafarpour et al. specifically highlights the potential benefits of nanocoatings in reducing solubility and surface roughness of glass ionomer cement. However, more research is needed to fully understand the potential benefits and limitations of nanocoatings for glass ionomer restorations, including their long-term performance and biocompatibility. In evaluating effects of nanofield coatings, it is important to consider characteristics of both coating and material being coated. Overall, advancements in nanotechnology may offer promising solutions for improving performance and longevity of restorative materials in the oral environment.

Keywords: Review, Nanofield, Restorative Materials, Ionomer

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Introduction

Nanofield coatings are a type of surface coating that use nanoparticles to enhance the properties of a material (1). One of primary benefits of nanofield coatings is their ability to improve a material's resistance to water and other environmental factors (2). Nanofilled resin-based coatings are a recent development in field of surface coatings, offering superior mechanical and physical properties (3), improved corrosion resistance, and enhanced durability (4). Incorporation of nanoparticles, such as silica, alumina, titanium oxide, and carbon nanotubes, into coating matrix can improve mechanical and thermal properties of coating, while also enhancing its barrier properties against moisture and other corrosive agents (5,6). Synthesis and characterization of these coatings have been widely researched, with effect of nanoparticles on properties of coatings being a major focus. Nanofilled resin-based coatings is another major advantage, with coatings able to be designed to have specific properties such as self-healing (7), anti-fouling, and anti-icing (8). Applications of nanofilled resin-based coatings in dentistry include fabrication of dental composites and adhesives, improving mechanical and bonding properties of restorative materials (9). Restorative materials with a base of glass ionomer, a versatile material that can be used in a variety of dental applications, have also become increasingly popular in dentistry. Glass ionomer restorative materials offer a unique set of benefits, including ability to bond directly to tooth structure, release fluoride, and provide a natural-looking restoration (10). Solubility and water absorption in glass ionomer cements can be evaluated using methods such as gravimetric analysis, microhardness testing, and Fourier transform infrared spectroscopy (11). Development of nanofilled resin-based coatings and use of glass ionomer restorative materials have immense potential in various industrial and dental applications.

Resin-based coatings

In recent years, use of nanotechnology has led to numerous innovations and improvements in various fields of science and technology. One of areas where nanotechnology has shown immense potential is in development of nanofilled resin-based coatings. These coatings have gained significant attention due to their ability to offer superior mechanical and physical properties, as well as improved corrosion resistance and more stability (4).

Resin-based coatings have been widely used in various industries such as automotive, aerospace, marine, and construction, among others (12). They offer excellent protection against corrosion, wear and tear, and environmental damage (13). However, with advancement of technology, there is an increasing demand for higher performance coatings with enhanced properties.

Nanofilled resin-based coatings

Synthesis and characterization of nanofilled resin-based coatings have been subject of extensive research in recent years. Nanofilled resin-based coatings have been developed to meet this demand. These coatings consist of a resin matrix filled with nanoparticles, which offer several benefits over conventional resin-based coatings (13). Use of nanoparticles in these coatings allows for improved mechanical properties, including hardness, tensile strength, and elasticity. In addition, nanoparticles can enhance thermal and electrical conductivity of coating, making them suitable for high-temperature applications (14).

Nanofilled resin-based coatings have also shown promising results in terms of their anti-corrosion properties (15). Wang et al. incorporated nanoplatelets/nano-silica hybrid nanofillers of in coating matrix to enhance barrier properties of coating, preventing penetration of moisture and other corrosive agents. This results in improved corrosion

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resistance and durability, making them ideal for use in harsh environments. (16).

In conclusion, development of nanofilled resin-based coatings is a significant advancement in field of coatings technology. These coatings offer several benefits over conventional resin-based coatings, including improved mechanical properties, corrosion resistance, and multifunctionality. With increasing demand for high-performance coatings, nanofilled resin-based coatings have immense potential in various industrial applications (17).

Nanofilled resin-based coatings in dentistry

Nanofilled resin-based coatings have numerous applications in dentistry. They are widely used for restoration of teeth, as they can be easily molded into required shape and size to match natural tooth structure. Use of these coatings has significantly improved quality of dental restorations and increased their longevity (18-20).

One major application of nanofilled resin-based coatings in dentistry is in fabrication of dental composites (21). Dental composites are tooth-colored fillings used to restore teeth that have been damaged by cavities, fractures, or other types of trauma (22). Incorporation of nanofillers into these composites has improved their mechanical properties, such as their strength, wear resistance, and fracture toughness, making them more durable and long-lasting (23).

Furthermore, nanofilled resin-based coatings have been used in development of dental adhesives. Dental adhesives are materials used to bond dental restorations to natural tooth structure. Using of nanofillers in these adhesives has improved their bonding properties, making them more effective in bonding restorative materials to tooth structure (24).

Restorative materials with base glass ionomer

Restorative materials with a base of glass ionomer have become increasingly popular in field of dentistry over past few decades. Glass ionomer is a versatile material that can be used in a variety of dental applications, including as a filling material, a liner or base for cavities, or as a cement for orthodontic brackets (25).

One of primary benefits of glass ionomer restorative materials is their ability to bond directly to tooth structure. This means that they can be used to restore teeth without need for a separate bonding agent, which can save time and simplify restorative process. Additionally, glass ionomer materials have a low coefficient of thermal expansion, which means that they expand and contract at a rate similar to natural tooth structure, reducing risk of cracking or fracturing (25, 26).

Another advantage of glass ionomer restorative materials is their ability to release fluoride over time. Fluoride is a naturally occurring mineral that can help strengthen teeth and prevent tooth decay. By releasing fluoride, glass ionomer restorations can help protect teeth against future decay and promote overall oral health (25, 26).

However, glass ionomer materials do have some limitations. They may not be as strong as other restorative materials, such as composite resins or ceramics, and may not be suitable for restoring teeth in areas of high stress or tension. Additionally, glass ionomer materials can be more sensitive to moisture during setting process, which can affect their strength and longevity (25, 26).

Overall, glass ionomer restorative materials are a versatile and effective option for many dental restorations. With their ability to bond directly to tooth structure, release fluoride, and provide a natural-looking restoration, they offer a unique set of benefits that make them an attractive choice for many dentists and patients.

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Methods of water absorption and solubility evaluation

Solubility and water absorption in glass ionomer cements (GICs) are commonly evaluated using various methods (27, 28). One common method involves immersing GIC samples in distilled water for a specific period and then measuring amount of water absorbed by samples or weight loss due to solubility (29). Another method involves using a centrifuge to apply pressure to sample in distilled water to simulate forces experienced by GICs in oral environment (30). Solubility and water absorption of samples can then be measured using same methods as before.

Solubility and water absorption of GICs are important factors to consider in dental restorations as they can affect longevity of restoration. High solubility or water absorption can result in dissolution or degradation of GIC, leading to a loss of retention or marginal breakdown of restoration. Therefore, evaluating these properties can help to identify suitability of GICs for different clinical applications and to optimize their performance in oral environment (28-30).

Nanofield coatings and water absorption and solubility of restorative materials with base glass ionomer

After conducting a search on the given topic, we were collected specific studies that directly address the impact of nanofield coatings on the water absorption and solubility of restorative materials with a base of glass ionomer; while studies were rare.

Many methods have been considered to increase the water sorption/solubility of glass ionomer–Based restorative materials(31). Jafarpour et al. performed an in-vitro laboratory study that investigates the impact of a nanocoating on the solubility and surface roughness of glass ionomer cement. They tried adding nanofilleds to these composites on five glass-ionomer cement (GIC) restorative materials. Found that their coatings caused decreased water solubility that prevents discolorations (32). The study found that the application of a nanocoating to glass ionomer cement resulted in a significant reduction in solubility and surface roughness compared to uncoated glass ionomer cement. The authors suggest that the nanocoating may help to improve the durability and longevity of glass ionomer restorations by reducing water absorption and surface degradation (32). Overall, this study provides valuable insights into the potential benefits of nanocoatings for glass ionomer restorative materials. However, it is important to note that this study was conducted in a laboratory setting and may not fully reflect the real-world conditions and challenges that can affect the performance of restorations in the oral environment (32).

Bacterial cellulose nanocrystals were added to resin-modified GIC by Moradian et al., to assess its effects on compressive strength, diametral tensile strength, and modulus of elasticity and all these mechanical properties were improved based on their experiments (33). Moghaddasi et al. used G-coat plus in comparison of the non-coated resin composites and found that water solubility improved but the color stability decreased (34). So, while glass ionomer restorative materials that are coated, are known to have relatively high-water absorption and solubility compared to other restorative materials, such as composite resins and ceramics, other factors like discoloration should also be investigated. In addition, while the results of this study are promising, further research is needed to fully understand the potential benefits and limitations of nanocoatings for glass ionomer restorations. Future studies could explore the effects of different types of nanocoatings, as well as their long-term performance and biocompatibility.

In summary, while there is no specific research on the effect of nanofield coatings on the water absorption and solubility of glass ionomer

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restorative materials, it is possible that such coatings could help improve the water resistance of the material. However, the individual characteristics of both nanofield coatings and glass ionomer materials should be considered when evaluating their effects on water absorption and solubility.

Conclusion

In conclusion, while there is limited research on impact of nanofield coatings on water absorption and solubility of restorative materials with a base of glass ionomer, available studies suggest that such coatings may help improve water resistance and durability of these materials. However, more research is needed to fully understand potential benefits and limitations of nanocoatings for glass ionomer restorations, including their long-term performance and biocompatibility.

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