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Review Article

Nanotechnology in Prosthodontics: A Review

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Abstract: ***Background*:** Numerous biomaterials used in prosthodontics have demonstrated dramatically improved performances after having their scales decreased by nanotechnology from micron to nano size. Contrarily, numerous nanocomposites made of nanomaterials and conventional metals, ceramics, resins, or other matrix materials have been extensively used in prosthodontics because the addition of the nanomaterials significantly improved the materials' properties, including modulus elasticity, surface hardness, polymerization shrinkage, and filler loading. ***Aim of the Study*:** In this paper, the most recent advancements in research on the prosthodontic applications of nanometals, nanoceramics, nano resins, and other nanomaterials were reviewed. This review not only provides a detailed description of the most recent related investigations, but also, hopefully, serves as an important elicitation for future studies in this area. ***Conclusion*:** Nanomaterials have proven fundamental to the development of basic science and clinical technology in prosthodontics. It demonstrates how the prosthodontic materials' many properties, including modulus of elasticity, surface hardness, polymerization shrinkage, and filler loading, can be significantly improved after their scales were reduced from micron to nano size by nanotechnology.

Keywords: Nanotechnology, prosthodontics, nanomaterials.

INTRODUCTION

An essential area of dentistry is prosthodontics [1]. Prosthodontics has drawn more and more attention as people's living standards have increased and oral health awareness has grown [2]. In addition to using artificial prostheses to treat periodontal disease, temporomandibular joint disease, and deformities of the maxillofacial tissues, prosthodontics is primarily concerned with treating dental problems and treating patients who have lost teeth using fillings, crowns, and dentures. [3, 4]. In order to deal with a matter at the nanoscale, or between 1 and 100 nanometers in size, a variety of technologies, techniques, and procedures are included under the umbrella term of "nanotechnology". Nanotechnology has been used to create a wide range of products, including technological gadgets, pharmaceuticals, building materials, and items used in dentistry [4]. By enhancing the mechanical and physical characteristics of materials and assisting in the development of novel diagnostic techniques and nano-delivery systems, it changed the dentistry sciences. The atoms that make up nanoparticles, which have special qualities and serve as the foundation of biological tissue, are sized on the nanoscale [5]. Comparatively to biological molecules interacting with micro or macro sized particles, the introduction of nano-sized particles enables an interaction on a molecular level, boosting the overall efficacy and affinity. The characteristics of materials that have been reduced to the nanoscale can unexpectedly change, offering novel uses. Examples include the transformation of inert materials into catalysts (platinum), the transparency of opaque substances (copper), the combustibility of stable elements (aluminum), At normal temperature, solids (like gold) transform into liquids and solids (like silicon) convert into conductors [6]. At nanoscales, substances like gold, which are chemically inert at larger scales, can act as powerful chemical catalysts. When scaled down to the nanoscale, this emphasizes the significance of using applied nanotechnology in a variety of industries, including dentistry [5]. Both fixed and removable prosthodontics now include numerous applications of nanotechnology. The development of nanocomposites, bonding agents, and the establishment of a connection between biomolecules and nanotechnology through the creation of biomaterials are notable developments [5].

Polymethyl Methacrylate Resin Nanoparticles

Carbon nanotubes have been incorporated in heat-cure monomers to reduce polymerization shrinkage and enhance mechanical characteristics. The flexural strength, antibacterial activity, and reduced porosity of standard polymethyl methacrylate have all been enhanced by the addition of metal oxide nanoparticles [7].

Nanoscale Metal Oxide Particles

To boost the viscoelastic property of resins, antimicrobial nanoparticles are added to polymethyl methacrylate. Biofilm adhesion to the denture base is the primary cause of oral pathological conditions such denture stomatitis. As an efficient antibacterial agent, silver and platinum nanoparticles are primarily used into the denture base materials. The viscoelastic qualities of the acrylic denture base material may be improved by the addition of AgNPs [8].

Investing in Maxillofacial Prosthesis

Tensile and tearing loads are the main causes of mechanical failure in maxillofacial prostheses. As a reinforcing agent, polyhedral oligomeric silsesquiox has improved the tensile and tearing strengths of traditional materials [6].

In Materials for Impressions

Vinylpolysiloxanes are combined with nanofillers to create a special siloxane additive for impression materials. Less voids at the margin and better model pouring are results of the material's improved hydrophilic characteristics and better flow [7].

Nano Composite Teeth

Nanocomposite denture teeth have a vibrant surface texture and are impact and stain resistant. Denture teeth comprised of nanocomposite materials are composed of polymethyl methacrylate (PMMA) and evenly dispersed nanofillers. Outstanding polishing and stain-resistance, exquisite appearance, vibrant surface structure, improved wear resistance, and increased surface hardness [8, 9].

In Fixed Prosthodontics

The development of newer light cure nanocomposites with numerous advantages, including the highest mechanical strength, lowest polymerization shrinkage, reliability, durability, low thermal expansion coefficient, low water sorption, excellent marginal integrity, and excellent handling characteristics, has been facilitated by the incorporation of nanofillers into the resin matrix [8].

Higher bond strength performance is facilitated by the use of silica nanofiller nanotechnology, which also offers a stable, filled adhesive. It creates a smooth, lustrous surface that is stain and wear resistant when applied as a coating agent over cosmetic restorations [10]. Before embedding composite or ceramic restorations, nanocare gold was used to improve the adhesive and antibacterial qualities [9].

Nanofillers improve polishability and lessen wear in nano-optimized moldable ceramics. The aesthetic is improved with nanopigments. Modifiers at the nanoscale enhance the handling quality. The mechanical qualities have been enhanced by the introduction of more modern resin luting agents that incorporate nanomodifiers [10]. Nanoceramic refers to the ceramic material with nanoscale dimensions in the microstructures phase. Nanoceramics differ from regular ceramics in that they have special qualities including high toughness and ductility. Nanoceramic offers better strength and hardness in terms of mechanical qualities. Many nanoceramics have four to five times the hardness and strength of conventional materials [11].

Nanotechnology in Implants

In the field of implantology, coating the implant surface with nanoceramics, such as hydroxyapatite (HA) particles and nanopolymers, has significantly improved interfacial attachment to bone tissue with benefits of quicker healing time, improved bone formation, firmer implant bone attachment, and a reduced release of metallic ions [11].

It has been established that using nano-titanium implants, where the surface topography of the implant is altered to a nanoscale, provides quick and ideal osseointegration. This method is based on the fundamental idea that improving implant stability can be achieved by considerably boosting the mechanical bonding of the cells by nano-roughening their surface [12, 13].

CONCLUSION

Nanomaterials have proven fundamental to the development of basic science and clinical technology in prosthodontics. It demonstrates how the prosthodontic materials' many properties, including modulus of elasticity, surface hardness, polymerization shrinkage, and filler loading, can be significantly improved after their scales were reduced from micron to nano size by nanotechnology. It also demonstrates how the performance of composites can be improved by incorporating the right nanomaterials.

Conflict of Interest: None.

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