Perspective

Nanotechnology: A New Era of Incredible Developments in the Field of Dentistry

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INTRODUCTION

The science and engineering that is conducted at the nanoscale is termed nanotechnology. In this, the materials that are used have components smaller than 100 nm in at least one dimension. Such materials are called nanomaterials and may include clusters, fibers, grains, nanoholes, or a combination of these forms. The surface area of such particles is increased and as a result, the material's chemical, physical as well as optical properties get improved [1]. Nanotechnology is emerging as an interdisciplinary field and has brought about a remarkable paradigm shift in medicine and dentistry [2].

APPLICATIONS OF NANOTECHNOLOGY IN DENTISTRY

Nanotechnology is applied in the vast majority of areas of dentistry [3]. Nano dentistry aims to enhance the precision, effectiveness and patient experience in dental care through the use of nanoscale materials and technologies [4].

TISSUE ENGINEERING AND REGENERATION, WOUND HEALING APPLICATION

Nanomaterials play a pivotal role in tissue engineering, facilitating enhanced regeneration and accelerated wound healing in dental applications. Specifically, nanocomposites can provide a biomimetic environment, promoting cell adhesion and proliferation for effective tissue repair [5].

FORENSIC DENTISTRY - DETECTION AND QUANTIFICATION OF TOXIC SUBSTANCES

In the realm of forensic dentistry, nanomaterials serve as powerful tools for the detection and quantification of various toxic substances within oral cavity evidence. Nano sensors with high sensitivity and selectivity contribute to the precision required in forensic investigations, ensuring reliable identification of toxic elements [6].

DENTINE HYPERSENSITIVITY

Addressing dentine hypersensitivity, nanomaterials offer a breakthrough by forming a protective barrier on exposed dentinal surfaces. Nano-sized hydroxyapatite particles, for instance, can effectively occlude dentinal tubules, reducing sensitivity and enhancing patient comfort [7].

INCORPORATION OF NANO FILLERS IN ARTIFICIAL TEETH

Artificial teeth now benefit from the integration of nano-fillers, enhancing their mechanical properties and longevity. Nanocomposites reinforce the structural integrity of artificial teeth, providing increased resistance to wear and tear, ultimately improving the overall performance and lifespan of prosthetic dental elements [8].

NANOPARTICLES IN TEETH WHITENING & BLEACHING

Nano materials have revolutionized teeth whitening and bleaching procedures, offering improved efficacy and reduced treatment times. Nanoparticles, such as those containing peroxide, can penetrate enamel more effectively, breaking down stains and discolorations with enhanced precision, leading to brighter and whiter smiles for patients [9]. Subgingival regions which are a major obstacle for dentists, can be easily accessed by nanomaterials and in this way drug delivery is facilitated which is required for treatment of periodontal diseases [2]. Dentifrices and mouthwashes supplemented with nanoparticles are the recent advancements which are improving maintenance of oral hygiene [10].

NANOPARTICLES IN PROSTHODONTICS

Nanoceramic materials which are used in fabrication of dentures are showing improved strength, color stability and decreased thermal and electrical conductivity [11]. Increased acceptance of denture is reported by patients which has metal nanoparticles such as titanium oxide and hydroxyapatite [2].

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NANOPARTICLES IN ORAL SURGERY AND ENDODONTICS

Within the domain of oral surgery, biocompatibility is enhanced as a result of advanced nanomaterials which are utilized for management of some oral diseases [12]. Implants having nanomaterials help in bone formation as they are capable of cells biomineralization and osteogenic differentiation [2]. Anti-cancer drug precise localization (to cancer cells only) is also achieved by nanotechnology and help in reducing systemic adverse effects [2]. Bonding and surface chemistry of nanoparticles are much better than traditional materials when incorporated as fillers within the domain of conservative dentistry. Such materials also have much improved anti-bacterial properties which are used in endodontic procedures including root repair, pulp regeneration, disinfection, canal filling etc. [13].

NANOPARTICLES IN ORTHODONTICS

The application of nanomaterials on orthodontic wires and brackets can decrease friction and mechanical resistance between them [14]. By incorporating antibacterial nanoparticles into orthodontic materials, a nano-coating can be created to hinder the formation of dental plaque around orthodontic appliances. This coating also helps prevent dental cavities commonly associated with orthodontic treatments [2].

NANOPARTICLES IN ORAL MEDICINE

The field of Nanotechnology has opened up new possibilities for advanced imaging and improved treatment of oral diseases. Organic and inorganic nanoparticles such as Silica, Zirconia, Hydroxyapatite, and Titanium dioxide have been utilized in oral medicine for therapeutic purposes [2]. Nanoimaging is also introduced in dentistry which is giving high quality images by utilizing minimal amount of radiation [2].

Thus, many benefits are offered by nanotechnology to the field of dentistry. Because of it, more advanced and biocompatible materials are synthesized which are applicable in different areas of dentistry. In future, we will see much more utilization of this technology for the benefit of mankind. Dentistry along with human life will be immensely changed by the advantages offered by this newer science. Other issues that may arise as a result of application of such technology including human safety, public acceptance ,regulation and ethics will also be subject of attention for concerned authorities [4].

Addressing ethical considerations in nanodentistry involves ensuring biocompatibility and minimizing toxicity of nanoparticles in dental applications. Long-term effects must be carefully monitored, necessitating extended patient observation for unforeseen consequences. Environmental impact, from production to disposal, demands ethical responsibility to mitigate potential harm. Informed consent is crucial, with patients informed about nanotechnology's risks and benefits. Adherence to regulatory standards is imperative, emphasizing ethical practices in nanomaterial use. Transparency in research reporting is vital, requiring honest communication of methodologies and limitations. Equitable access ensures nanotechnology benefits reach diverse populations, avoiding healthcare disparities. Interdisciplinary collaboration among dentists, scientists, ethicists, and regulators is key to ethically navigating nanodentistry challenges and promoting responsible innovation (Fig. **1**).

Fig. (1). Uses of Nanomaterials in Dentistry.

CONFLICT OF INTEREST

Declared none.

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