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IP International Journal of Periodontology and Implantology

Journal homepage: https://www.ijpi.in/

Short Communication

Scaling down for better periodontal health: The role of nanotechnology

Riya Divyakant Dave [1,*]

[1] *Ahmedabad Dental College and Hospital, Ahmedabad, Gujarat, India*

ARTICLE INFO

Article history:
Received 31-03-2023
Accepted 05-04-2023
Available online 22-04-2023

Keywords:
Nanotechnology
Periodontal disease
Drug delivery
Tissue engineering
Implant success
Bone defect repair
Safety issues

ABSTRACT

Nanotechnology has emerged as a promising approach in the treatment of periodontal diseases, which affect a large proportion of the population worldwide. By studying nanotechnology, we can gain a better understanding of how these materials can be used in daily practice. Nanotechnology involves the development of materials, devices, and systems that exhibit unique physical, chemical, and biological properties at the nanoscale level. This technology has the potential to revolutionize the prevention, diagnosis, and treatment of oral diseases, including periodontal disease, which affects a significant portion of the global population. The use of nanotechnology in dentistry, also known as Nano dentistry, provides promising solutions for the treatment of various dental disorders, including periodontal disease. This article summarizes the current research trends in periodontal nanotechnology, including nanoscale drug delivery systems and nanomaterials for tissue engineering and regeneration. Nanoparticles offer significant advantages over conventional drug delivery systems due to their controlled release and improved bioavailability, making them a promising approach for periodontitis treatment. Furthermore, nanomaterials act as three-dimensional scaffolds, providing a favourable environment for tissue regeneration by promoting cellular adhesion, proliferation, and differentiation. The potential of nanotechnology in tissue engineering is vast, and its application in bone defect repair and implant success rates has shown great potential. However, safety issues and biological risks must be addressed before routine implementation of nano dentistry in periodontal treatment. Overall, this article provides insights into the potential of nanotechnology in periodontics and its translation into a more specific approach of nano periodontology in periodontology.

1. Introduction

Nanotechnology is the art and science of material engineering at less than 100 nanometer scale. The first definition of "nanotechnology" was given by Norio Taniguchi (Tokyo Science University) in a 1974 paper. According to him, "nanotechnology" mainly deals with the separation, consolidation and deformation of materials by through an atom or a molecule. Nanomaterials are synthetic or natural materials whose constituents are smaller than 100 nm in at least one dimension, including clusters of atoms, grains with a size of less than 100 vnm, fibers with a diameter of less than 100 nm, films thin less than 100 nm thick, the nanopores, and make up its combination.[1]

The incorporation of nanotechnology onsidered as one of the major advances in the field of periodontics. Periodontal disease is one of the most common diseases in the world, affecting about 90% of the population, and the prevalence rate in developing countries like India reaches 96.30%. Most periodontal diseases are the result of untreated inflammatory processes occurring in different periodontal structures (i.e., gum, bone, periodontal ligament and cementum). A major challenge in the treatment of these periodontal diseases is the accessibility of the inflamed area. With the advent

* *Corresponding author*.
E-mail address: Riadave334@gmail.com (R. D. Dave).

https://doi.org/10.18231/j.ijpi.2023.011

of new procedures and more = precise instruments, the accessibility of spatially restricted areas is much better, and the introduction of nanotechnology in periodontal treatment and its collaboration with existing modalities not only contributes to better treatment options, and it will also improve accuracy and make treatments more targeted.[2]

This article aims to summarize and simplify current research trends regarding periodontal nanotechnology, their uses, benefits, various treatment options, and the use of dental nanobots, while discussing barriers, safety issues, and the potential their use in routine procedures. biological risk. This article also proposes a step towards the translation of nanodentistry into a more specific approach of nanoperiodontology in periodontology.

2. Nanoscale Delivery Systems

Nanoscale drug delivery systems are designed to deliver therapeutic agents to specific cells or tissues with high precision and efficacy. The unique properties of offer significant advantages for nano-drug delivery over emulsion-based carriers and microparticles. For instance, it enables the controlled release of drugs, enhancing their stability and dissolution in aqueous medium. Furthermore, the small size of nanoparticles facilitates their transportation against the cell membrane, improving their bioavailability and reducing clearance. They also offer better drug loading ability due to their increased surface area per unit mass and higher surface reactivity. These properties make this a promising approach for periodontitis treatment.[3]

A range of nanoparticles are being utilized for drug delivery in periodontal treatments including nanospheres, nanogels, nanocomposites, nano capsules, nanofibers, dendrimers and liposomes.[3] For example a study done by Lee et al in 2016 showed that Poly-D, L-lactic-co-glycolic acid derived nanocarriers loaded with tetracycline and lovastatin demonstrated effectiveness in treating canine models with periodontitis. They found out that it was not only biocompatible but also inhibited bacterial growth in human therapy.[4]

3. Nanomaterials for Tissue Engineering and Regeneration

Nonsurgical mechanical therapy may be sufficient to manage periodontal inflammation and remove subgingival microbial biofilm, but for complete restoration of the periodontium, regeneration of alveolar bone defects is necessary. In recent years, the use of biomaterials in oral tissue engineering has had a positive impact in this regard. These biomaterials act as three-dimensional scaffolds, providing a favourable environment for tissue regeneration by promoting cellular adhesion, proliferation, and differentiation. The scaffold must possess the ability to promote osteogenesis, osteoinduction, and osteoconduction processes, and preosteogenic cells must be delivered or attracted to its surface and activated by osteoinductive growth factors.[5]

4. Nanotechnology in Periodontics

Pinon-Segundo et al. (2005) developed triclosan-loaded nanoparticles through the emulsification-diffusion method for the effective management of periodontal diseases. The nanoparticles were fabricated using poly (D, L-lactide-co-glycolide), poly (D, L-lactide), and cellulose acetate phthalate, with poly (vinyl alcohol) serving as a stabilizer. Different triclosan concentrations were utilized to assess its impact on the properties of the nanoparticles. The release kinetics showed that the depletion zone migrated towards the centre of the device as the drug was released, indicating that the release was primarily governed by diffusion.[6]

The potential of nanotechnology in tissue engineering is vast and continues to expand. Polymer scaffolds that can support cell growth and deliver growth factors have already been developed, and the possibilities for further manipulation with nanodevices implanted at tissue damage sites are limitless.[7]

Insufficient bone formation around dental implants is a major cause of implant failure. In order to facilitate bone formation, implant surfaces need to be modified. Nanostructured implants are being developed to combine the biocompatibility and mechanical properties of the dental implant alloy, resulting in improved implant success rates.[8]

Nanotechnology has shown great potential in bone defect repair, especially in the form of nano-bone graft materials. These materials must possess similar qualities to traditional bone grafts, but their higher surface area to mass ratio allows for more effective treatment of intrabony defects. Additionally, nanoneedles and nanotweezers are currently being developed for the purpose of cell surgery, which may become a reality in the near future.[9]

While there are many ambitious ideas for the application of nanotechnology in dentistry, there are significant challenges that must be overcome before they can become a reality. These challenges include engineering difficulties in assembling nanoscale components, biological challenges in developing molecules that are both biocompatible and environmentally friendly, and social challenges in ensuring that these technologies are economically viable and ethically acceptable. Despite the progress made in this field, there is still much work to be done before nano dentistry can reach its full potential.[10]

5. Conclusion

Nanotechnology has shown significant potential in the diagnosis, management, and prediction of various treatments. Although complete and proper regeneration of periodontal tissues remains a distant goal, recent

advancements in nanomaterials and nanotechnology have opened up promising avenues for commercial applications of nanomaterials in the diagnosis and management of periodontal diseases. It is increasingly important to specifically develop nanomaterials tailored for the management of periodontal diseases. As more nanotechnologies are explored commercially, it is expected that this trend will continue to improve in the future.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Author biography

Riya Divyakant Dave, Intern https://orcid.org/0000-0003-0067-1317

Cite this article: Dave RD. Scaling down for better periodontal health: The role of nanotechnology. *IP Int J Periodontol Implantol* 2023;8(1):56-58.