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Editorial

Nanotechnology and periodontics

Deepith Kelotte *, **Anil Melath**, **Subair Kaykool**, **Panditha Chandran**

Department of Periodontics, Mahe Institute of Dental Sciences and Hospital, Puducherry, India

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***Correspondence:**
Deepith Kelotte
Department of Periodontics, Mahe Institute of Dental Sciences and Hospital, Chalakkara, Pallor, Mahe, Puducherry 673310, India.
Email: deepithchdk@gmail.com
Tel: +91-7012386342

ORCID iDs
Deepith Kelotte
https://orcid.org/0000-0001-6137-9841
Anil Melath
https://orcid.org/0000-0001-9321-7708
Subair Kaykool
https://orcid.org/0000-0001-6981-879X
Nanditha Chandran
https://orcid.org/0009-0008-0286-4351

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The periodontium consists of the investing and supporting tissues of the tooth, gingiva, and attachment apparatus, including the periodontal ligament, cementum, and alveolar bone [1]. The physiological function of the periodontium can only be preserved through the maintenance of structural integrity and a complex interplay among its four distinct elements: the gingiva, periodontal ligament, cementum, and alveolar bone.

The periodontium undergoes morphological and functional variations, as well as changes associated with age. Traditional treatments such as scaling, root planing, and periodontal flap surgery have been shown to be effective. The treatment of progressive periodontal diseases has been proven beneficial when combined with adequate post-operative supportive periodontal care [1]. Specialised nanoparticles, with particle sizes measured in nanometres, can be engineered to target oral tissues, including the periodontium. Nano-scale biosensors can be used to diagnose periodontal disorders. These sensors are capable of identifying substances found in bodily fluids such as saliva, blood, and gingival crevicular fluid [2]. These nanotechnologies are also employed for administering medication, injecting local anaesthesia, and for diagnostic purposes. Dentists can control nanorobots using onboard computers, transmitting signals for specific treatment techniques. Dentifrobots are devices that reside sub-occlusally and are administered via mouth rinse or toothpaste [3]. These dentifrobots can inspect supragingival and subgingival areas at least once a day, aiding in the ongoing removal of calculus and converting trapped organic molecules into harmless, odourless vapours [4]. Nanorobots will have the ability to distinguish between different types of cells by analysing their surface antigens. This is achieved by using chemotactic sensors that are tuned to specific antigens on target cells. Once the nanorobots have completed their task, they can be removed through the human excretory system or by active scavenger systems [4]. Nanoparticles offer numerous advantages in the delivery of bioactive chemicals and drugs.

Nanorobotics refers to the microscopic counterparts of actual machines, scaled down to the nanometre size. These are designed to operate within a molecular environment and, in theory, could be utilised to construct devices capable of detecting and even eliminating the causes of diseases. Nanotechnology has found an application in toothpaste, specifically in the form of abrasives in the correct proportions. Numerous companies have taken the initiative to develop nano-abrasives as a component of their products, contributing to the creation of brighter smiles.

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According to a study by Floriano et al. [5], salivary nano-scale biosensors have proven useful in detecting acute myocardial infarctions, thereby assisting in identifying changes in patients. Biocompatible nanocomposite hydrogels, which are also synthesised as a local drug delivery strategy, form a 3-dimensional cross-linked polymer network when immersed in water. These hydrogels have a soft and pliable texture. Periochip® (Dexcel-Pharma Limited, Northamptonshire, UK) is a type of hydrogel used to deliver chlorhexidine digluconate [6]. Nanocomposite biocompatible hydrogels are currently being developed as a treatment for periodontal diseases [7]. Biodegradable scaffolds have been employed for periodontal regeneration. Recent advancements in nanotechnology have been ground-breaking due to their ability to enhance the osteogenic properties of cells. Nano-scaffolds surpass various traditional methods used for tissue regeneration and bone augmentation in every aspect [8]. Polycaprolactone or calcium carbonate nanofiber-infused membrane components have been developed for guided bone regeneration, offering superior mechanical and tensile strength. Osteoblasts are attracted to and multiply on the membrane surface, facilitating cell attachment [9]. Ostim (Osartis GmbH & Co., Dieberg, Germany), VITOSSO (Orthovita, Inc., Malvern, PA, USA), and NanOSS (Angstrom Medica, Woburn, MA, USA) are marketed hydroxyapatite-based bone replacement products that utilise nanotechnology. Dentifrobots, as previously mentioned in relation to dentifrices, represent an innovative breakthrough. They can locate and eliminate harmful bacteria residing within plaque while promoting the growth of harmless species of oral microflora in a healthy environment. Dentifrobots also provide continuous halitosis protection. Suture needles made with nanosized stainless steel crystals have also been produced.

While dealing with gingival recession, there is a high risk of dentinal hypersensitivity following treatment methods like glass ionomer cement restorations. Traditionally, hypersensitivity toothpaste is the recommended solution. However, with advancements in nanotechnology, reconstructive dental nanorobots have the potential to precisely occlude the dentinal tubules in mere moments. This provides patients with immediate and enduring relief from dentin hypersensitivity [10].

In the realm of nanotechnology and its relationship with implants, it has been demonstrated that dental implants engineered both chemically and mechanically exhibit superior osseointegration. This is largely due to various nanoscale modifications, including the creation of nano-regions such as nano-grooves and nanopillars [11]. Commercially available nanohydroxyapatite-coated implants, like the NanoTite BIOMET 3i, contain approximately 50% nanohydroxyapatite. One of the most serious challenges a periodontist can encounter is implant failure, often referred to as peri-implantitis. There are several traditional treatment methods available to address peri-implantitis. However, in the modern era, nanotechnology has provided an alternative approach. This involves stabilising the clot using nanohydroxyapatite on a citric acid-conditioned surface, which in turn promotes the proliferation of fibroblasts with the aid of platelet-derived growth factor-BB [12].

Research has increasingly turned towards nanotechnology and related sciences, which promise to revolutionise the fields of medicine and dentistry, leading to improved health and quality of life. Dentistry, in particular, is poised to leverage these advancements to enhance both aesthetic and functional outcomes, moving beyond traditional methods to microscopic interventions. Current scientific evidence supports the use of nanoparticles and related products in treatment planning and execution, suggesting a significant potential for the growth of nanotechnology within dentistry. While research on nanocomposite and

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nanoporous materials has already been conducted, it is proposed that the development of nanomaterials for the treatment of periodontal diseases is crucial. This approach is likely to progress further as more nanotechnologies are explored both commercially and scientifically in the future.

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