

REVIEW ARTICLE

Nanodentistry – The Future Looks Big in Small

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ABSTRACT

Nanotechnology has been recognized now as a new alternative and a possibly superior approach for the identification of oral health-related problems and also in designing of more biocompatible dental materials with better properties and anti-carries potential. Nanodentistry is striving its best to apply new advances in dental practice. The present article reviews the use of nanotechnology in dentistry and also the latest innovations in oral health care, nano incorporated products, and issues of patient safety and occupational health.

Keywords: Nanodentistry, Nanodiagnosics, Nanodrugs, Nanomaterials, Nanorobots, Nanosurgery, Nanotechnology.

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INTRODUCTION

Today, we are witnessing an unprecedented growth in research in the area of nanoscience. There is increasing optimism that nanotechnology applied to dentistry will bring significant advances in the diagnosis, treatment, and prevention of disease. “Nano” is derived from the Greek word for “dwarf.” “Nanotechnology” is defined as the research and development of materials, devices, and systems exhibiting physical, chemical, and biological properties that are different from those found on a larger scale.^[1,2] Nanotechnology, also known as molecular engineering, is the production of functional materials and structures in the range of 0.1–100 nanometers by various physical or chemical methods. The concept of nanotechnology was introduced in 1959 by late Noble Physicist Richard P Feynman. The term “Nanodentistry” was first introduced in 2000 by research scientist Robert Freitas. Nanodentistry will make possible the new potential treatment opportunities in dentistry which include, local anesthesia, dentition renaturalization, permanent hypersensitivity cure, complete orthodontic realignments during a single

office visit, covalently bonded diamondized enamel, continuous oral health maintenance using mechanical dentifrobots, and creation of artificial bone and teeth.^[3]

NANODENTISTRY

As nanomedicine advanced, dentistry also started evolving in the field of nanotechnology. It is envisaged that nanotechnology will affect the fields of diagnosis, materials, restorative dentistry, and surgery. These exciting new branches, namely, nanorobotics, nano-diagnosis, nanomaterials, and nanosurgery and nanodrugs will profoundly impact clinical dentistry in the not-so-distant future. Science fiction will soon become reality.^[4,5]

NANODIAGNOSIS

Nanotechnology supplements the diagnosis and treatment of oral cancer. Nanotechnology detects biomarkers of tumor cells and thus discovers them earlier and increases sensitivity of test. Such a technology is superefficient at diagnosing cell changes. The false-negative rate of diagnosis would be virtually zero. Nanoparticles have extremely high surface area due to small size of atoms due to which various functional groups get attached to them and thus they may bind to tumor cells. Quantum dots have been used as contrast agents *in vivo* and *in vitro* for magnetic resonance imaging (MRI) and ultrasound. Quantum dots are inorganic semiconductor nanocrystals of cadmium selenide, which are <10 nm and are used as probes for diagnosis of oral cancer. Quantum dots travel through the bloodstream and help in improving the visualization of tumor sites in conjunction with MRI. Nanoshells are also used as contrast agents with medical imaging technologies. These are made up of silica and gold. In the spectral region from ultraviolet to infrared, they perform optical properties by conversion of electrical energy into light.^[1-3,6]

NANODENTAL MATERIALS

Various nanomaterials can be used for restoration of decayed, carious, missing, and fractured teeth. Recent advances in nanomaterials have brought nanocomposites, nanoimpression, and nanoceramic into the domain of clinical dentistry. Composite materials should have two important properties, i.e., strength and esthetics.

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Both these properties largely depend on the filler particle size. From the traditional filler particles till micro-filled particles, esthetic properties have improved but not so the strength properties. Trying to create a new material having both these properties, namely, the mechanical strength and esthetic and polishing qualities, nanofillers have been introduced. Nanocomposites have three different filler components, namely, non-agglomerated discrete silica nanoparticles, barium glass, and prepolymerized fillers. Filtek Ultimate Body and Filtek Ultimate Translucent (nanofilled composites) when compared to GC Gradia Direct Anterior (microfilled) and Filtek Z250 (microhybrid composite) nanofilled composites were found to have superior properties than other more traditional composite resins. Polymethyl methacrylate, due to its exclusive advantages such as good optical properties, biocompatibility, easy processing, and reparability, has been used for almost all of the removable dental prostheses. Ceramics have been used in prosthodontics in the manufacture of dental crowns and dentures considering these ceramics' high strength, suitable color, and low thermal and electrical conductivity. Still, their high brittleness is a cause of concern. Nanocomposite artificial teeth are also a new development in this field. Nanoinorganic fillers are diffused in the matrix of composite. These are more durable as well as highly resistant to abrasion with superior color. In dental implants, one of the most common reasons of failure is insufficient bone formation around the implant. For sufficient bone formation, surface of implants needs to be altered, which includes nanoscale topography and/or coatings for better and faster osseointegration of implants. An ideal impression material should record the details of a patient's mouth with precision. Nanofillers are added to the polyvinylsiloxanes to improve their properties. These materials exhibit better flow, improved hydrophilic properties, enhanced, detailed precision, and less voids at the margins.^[1,7-11]

NANOSURGERY

Nanoneedles and nanotweezers are also being developed that will make cell surgery a possibility in the near future. Suture needles incorporating nanosized stainless steel crystals are being developed, which may be used to produce incisions at the cell level.^[4-6,12]

NANODRUGS

Triclosan-loaded nanoparticles are produced for the treatment of periodontal disease. Hollow spheres, core-shell structure, nanotubules, and nanocomposite can be used as periodontal drug delivery system in near future for the treatment of periodontal pocket.^[1,5,13,14]

CONCLUSION

Nanodentistry is a multidisciplinary field of scientific research in dentistry that highlights the application of new nanomaterials and devices in all the areas of human activity. Nanomaterials and nanorobots are of great interest when considering advances in nanotechnology. However, more investigations and clinical trials are required for the application of nanotechnology in oral health and dental care.

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