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REVIEW ARTICLE

Nanodentistry : Dream of Today, Reality of Tomorrow

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Introduction

Nanotechnology is the manipulation of matter in the molecular and atomic levels. Its concept was first elaborated in 1955 by the late Nobel Prize winning physicist, Richard P. Feynman. Nanotechnology in dentistry is a research on a new approach towards dentistry, using nanosized restorative materials, nanodimensio -nal drugs and newer technologies with nanomachines.

Nanodentistry includes-

- Nanomaterials
- Nanorobots

Nanomaterials

Recent advances in nanomaterials have brought nanocomposites, nanoimpression materials and nanoceramic into the domain of clinical dentistry. Nanofillers have better mechanical strength and polishing qualities, and nanozirconia ceramics are used in the manufacture of dental crowns.

Nanorobots:

Nanorobots have a diameter of 0.5-3 microns and made of components sized from 1-100 nanometres. These nanorobots which are carbon based molecules, are largely in the research and development phase. They are computer controlled microscopic devices enabling clinicians to execute accurate procedures at the cellular and molecular level.

Uses of Nanotechnology in Various Fields of Dentistry

1. Nanotechnology in Local Anaesthesia

Colloidal suspension with millions of active analgesic nanorobots will be applied in the gingiva of required tooth. These nanorobots will then reach the pulp within minutes, and shut down pain in the specific tooth. After finishing of the procedure, clinician can make the nanorobots restore all the sensations.

2. Nanotechnology in Orthodontics

Recent advancement in orthodontic treatment to reduce undesirable friction is nano-coated arch wires and brackets. Nanoparticles of tungsten-disulfide and nickel-phosphorus nano particles have been recently used to coat Nickel-Titanium(NiTi) and stainless steel wires.

Dr. Sims proposed the use of nanorobots instead of brackets, programmed to control bone and periodontal ligament response to achieve painless tooth movement in less duration of time.

3. Nanotechnology In Site Specific Drug Delivery

Targeted drug and gene delivery system have been developed by Osaka University in Japan. Controlled drug delivery using nanoparticles reduces drug dosage related side-effects. It will be a boon in cancer treatment where tremendous side-effects of the drug are seen. Recently, new drug delivery systems have been developed using nanoparticles with triclosan, which will halt the advancement of periodontal disease.

4. Nanotechnology in Caries Control

To control caries, use of genetically modified bacteria BCS3-L1[4](NANOROBOT). But how will they work?

· Identify the pathogenic microorganisms S. mutans, and replace it

· No production of acid from sugar.

Tschoppe et al. stated that caries can be prevented with toothpaste containing nanohydroxyapatite which would help to enhance remineralisation of enamel and dentin.

5. Nanotechnology in Hypersensitivity Cure

Hypersensitive teeth have dentinal tubules with twice the normal diameter. Nanorobots will reach the pulp chamber in just 100 seconds. They can occlude the dentinal tubules in more target specific and precise manner, resulting in quick and permanent recovery with precise and selective occlusion of dentinal tubules.

6. Nanotechnology in Correction of Bone Defects

Nanophase materials have a potential to be used in correction of maxillofacial defects. Two main types of nanophase materials used

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are nanophase hydroxyapatite(HA) and nanophase carbon. Nanophase HA(eg. Nan OSSTM HA, Ostim HA) has superior osteoblastic adhesion compared to traditional HA. Nanophase Carbon has superior biomechanical properties.

7. Nanotechnology in Dental Cosmetics

Nanocomposite material comprises of nano filler particles of size 1-100nm. diffused in the matrix of composite, which increases the durability and resistance to abrasion. The resulting superior colour and translucency increases the overall esthetics of the restoration.

8. Nanotechnology in Oral Cancer

' Quantum dots', which are tiny nanoparticles of size <10nm, show a very bright luminance when viewed under UV light. If coated with a material showing affection to cancerous cells, they can help in locating and detecting cancer cells at an early stage. Nanorobots can be applied to precisely deliver exact amount of chemotherapeutic agents directly to the target cells, sparing the normal cells, which will reduce the side effects. Such drug delivery nanorobots were termed 'Pharmacytes' by R.A. Freitas in 2000.

9. Nanotechnology in Periodontal Disease

Programmed nanorobots could identify and destroy pathogenic, disease specific bacteria harbouring the plaque, leaving aside the beneficial oral microflora, thus playing a key role in treatment of gingival and periodontal diseases.

10. Nanotechnology in Dental Implants

Nanoscale topographic modification increases the implant osseointegration. It includes immobilization of specific, active biomolecules known for their central role in osteogenesis on the surface of implants. Eg. Alkaline phosphatise, calcium phosphate coating and bone morphogenic protein.

11. Nanotechnology in Prosthodontics

Nanofillers, presently added to polyvinylsiloxane impression material, results in better flow, improved hydrophilic properties, detailed precision and less voids at the margin. Nanozirconia ceramic, used in the manufacture of dental crowns and dentures show excellent corrosion resistance, high fracture toughness and translucency.

Challenges faced by nanodentistry :

- Ø Biocompatibility
- Ø Economical nanorobot production technique
- Ø Precise positioning of nanomolecules
- Ø Co-ordination of activities of large numbers of independent nanorobots
- Ø Public acceptance and human safety

Problems for research in India :

- Ø Painfully slow strategic decisions
- Ø Sub-optimal finding
- Ø Lack of engagement of private enterprises
- Ø Problem of retention of trained manpower

Conclusion

It sounds like a science fiction, but as said by the late Noble Prize winner P. Feynman, “THIS IS A DEVELOPMENT WHICH I THINK CANNOT BE AVOIDED.” However, with developments it may also pose a risk for misuse. If used properly, it will revolutionize the diagnosis and treatment planning in the near future, alongwith tissue regenerative materials for improving esthetics in dental field.

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