IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 8 Ver. X (Aug. 2017), PP 38-41
www.iosrjournals.org

Role of Nanotechnology in Advancement of Periodontology

Neha Yadav[1*],Probal Soud[2],Rani Yadav[3],Mohsin Khan [4], Krishna Kant[5]
Rajasthan University of health sciences, India
Nobel Medical College, Nepal
AECS Maruthi College of Dental Sciences and Research Center, India
TatyasahebKore Dental College and Research Centre, India
Technical University of Denmark (DTU-Food), Denmark
[*]*Corresponding author:NehaYadav*[*]

Abstract :*Almost every facet of life from security to medicine is influenced by nanotechnology. The concept of which in simple words is that when one goes down to the bottom of things, one can discover unlimited possibilities and potential of the basic particle. Analysis can be made to the level of manipulating atoms, molecules and chemical bonds between them in nanotechnology.Nanotechnology is developing fast in recent years and like other medical fields it is also set to transform dentistry in a huge way. Periodontitis is a multifactorial polymicrobial infectious inflammatory disease of the tooth supporting structure.With upsurge of various treatment methodologies for treatment of periodontitis nanotechnology has evolved as a promising mode of treatment. It utilizes nanomaterials, nanobiotechnology and nanorobots for the treatment and maintenance of periodontal health. The purpose of this paper is to review the phenomenon of nanotechnology as applied to periodontics.*

Keywords:*Nanotechnology, Periodontology,Dentifrobots, Dentistry.*

Date of Submission: 12 -08-2017 Date of acceptance: 23-08-2017

I. Introduction

With a soaring trend in increasing the survival age of the population, scientist are now looking for options to construct biologic substitute with the help of tissue engineering and regenerative medicine. In recent years various biomaterials have been structured at 'nano' scales that form ideal interface with tissues. We have now moved to new concept and approach of building from small to bigger building blocks elements called nanotechnology.The central idea of nanotechnology is to employ individual atoms and molecules to construct functional structures. Nanotechnology has revolutionized all fields including health care to engineering beyond traditional and dentistry is also no exception. The speed at which progress has been made in science has introduced nanotechnology to dentistry from its theoretical basics instantly into the actual world.[1]Two main approaches are used in nanotechnology. In the 'bottom up' approach materials and components are built from molecular components which assemble themselves chemically by principles of molecular recognition. In the 'top down' approach, nano objects are constructed from larger entities without atomic level control.[2]The various nanoparticles are as follows 1. Nanopores2. Nanotubes 3. Quantum dots 4. Nanoshells 5.Dendrimers 6.Liposomes 7.Fullerenes 8.Nanospheres 9.Nanowires 10.Nanobelts 11.Nanorings 12.Nanocapsules.[3]Basically, nanotechnologies consist of three mutually overlapping and progressively more powerful molecular technologies:

1. Nanoscale structured materials and devices that can be fabricated for advanced diagnosis and biosensors, targeted drug delivery and smart drugs
2. Molecular medicine via genomics, proteomics, artificial biobotics (microbial robots)
3. Molecular machine systems and medical nanorobots allow instant pathogen diagnosis and extermination and efficient augmentation and improvement of natural physiological function.[4]

II. Nanotechnology Use In Periodontics

Periodontitis being the most common disease involving tooth and it's supporting structures also has impact on overall health of an individual. Management of periodontitis is hence important for improvement of quality of life of the patient.

2.1NanoroboticDentrifices (Dentifrobots)

Dentifrobots in the form of mouthwash or toothpaste can clean organic residues by moving throughout the supragingival and subgingival surfaces, metabolizing trapped organic matter into harmless and odourless

vapors and performing continuous calculus debridement when left on the occlusal surface of teeth. These nanorobots can move as fast as 1-10 μ/s and are safely self-deactivated when they are swallowed.[5]

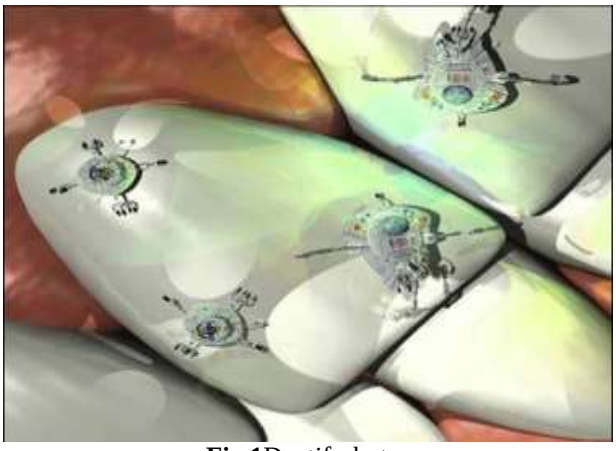

Fig.1 Dentifrobots

2.2Dentin Hypersensitivity Cure

The usually cause of dentin hypersensitivity is changes in pressure and transmitted hydrodynamically to the pulp. The hypersensitive teeth have tubules diameter double than nonsensitive teeth and about eight times higher surface density of dentinal tubules. Dental nanorobots can precisely and selectively occlude selected tubules in minutes, using native biologic materials, offering patients a quick and permanent cure.[6]

2.3 Nanomaterials For Periodontal Drug Delivery

The widely usednanomaterialsfor controlled drug release are core-shell spheres, hollow spheres, nanotubes and nanocomposite.Drugs can be incorporated into nanospheres composed of a biodegradable polymer, and this allows for timed release of the drug as the nanospheres degrade facilitating site-specific drug delivery.[7]Recently, Pinon-Segundo et al produced and characterized triclosan-loaded nanoparticles by the emulsification–diffusion process, in an attempt to obtain a novel delivery system adequate for the treatment of periodontal disease. The nanoparticles were prepared using poly (D, L-lactide-coglycolide), poly (D,L-lactide) and cellulose acetate phthalate. poly (vinyl alcohol) was used as stabilizer. These triclosannanoparticles behave as a homogeneous polymer matrix-type delivery system, with the drug (triclosan) molecularly dispersed.[8]Tetracycline incorporated into microspheres is available as Arestin for drug delivery by local means into periodontal pocket [9]

2.4 Nanomaterials To Induce Bone Growth

Bone is a natural nanostructured composite composed of organic materials like collagen reinforced with inorganic ions in the form of hydroxyapatite crystals. This natural nanostructure uses the nanotechnology to emulate for dental applications. As the particle size decreases, the surface area becomes larger in volume. Nanobone uses this basic principle of nanostructure.[10]Nowadays alloplastic bone grafts are being developed with nanoscale particles. Nano-HAP (n-HAP) bone grafts, which are available in crystalline, chitosan-associated and titanium-reinforced forms is one such type of bone graft. These n-HAP composite bone graft scaffolds are highly biocompatible, have superior mechanical properties, and induce better cellular responses compared to 'plain' chitosan scaffolds.[11],[12]

3. Laser Plasma Application For Periodontia

Use of nano-sized Titania particle emulsion on human skin followed by laser irradiation, leads to the disintegration of the particles along with other results like: • Shock waves • Microabrasion of hard tissues • Stimulus to produce collagen.[16] Clinical applications of this laser plasma application in periodontia are periodontal therapy, melanin removal and soft tissue incision (without anesthesia).[17,18]

4. Nanotechnology in dental implants

Nanotechnology can be used in the surface modifications of dental implants since surfaces properties such as roughness and chemistry play a determinant role in achieving and maintaining their long-term stability in bone tissue.[7,10] Deficient formation of bone around the biomaterial immediately after the implantation is the most common reason for failure of dental implant.The coating of nano particles over the dental implants, improves the adhesion and integration of surrounding tissues.[14]

Biologically active drugs such as antibiotics or growth factors can be incorporated in the implants. eg: Nanotite™ Nano-Coated Implant. Recently three nano-structured implant coatings are developed:
•Nanostructured diamond: They have ultrahigh hardness, improved toughness over conventional microcrystalline diamond, low friction, and good adhesion to titanium alloys. [15] •Nanostructured processing applied to hydroxyapatite coatings: This is used to achieve the desired mechanical characteristics and enhanced surface reactivity and has been found to increase osteoblast adhesion, proliferation, and mineralization. [15]
•Nanostructured metalloceramic coatings: These provide continuous variation from a nanocrystalline metallic bond at the interface to the hard ceramic bond on the surface. [15]

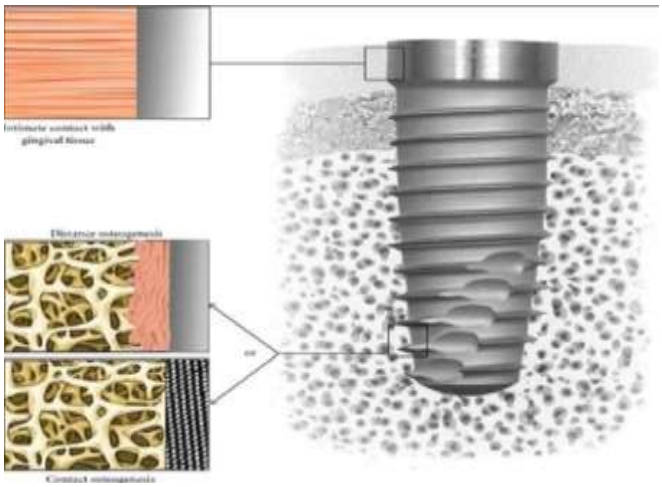

Fig.2 Nanosurface modification of Implants. Modifying surface roughness has been shown to enhance the bone-to-implant contact and improve their clinical performance.

5. Tooth Repair

Chen et al made use of nanotechnology to simulate the natural biomineralisation process to create the hardest tissue in the body, the enamel by using highly organized microarchitectural units of nano-rod like calcium hydroxapatite crystals arranged parallel to each other. [13]

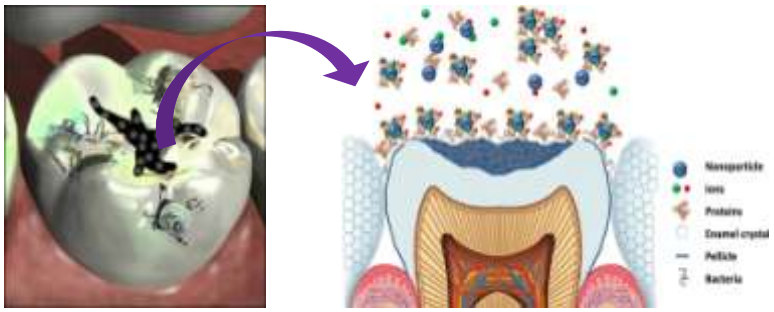

Fig.3chemical composition, and reactivity of dental tissues in the context of interactions with ENMs ,including the saliva, pellicle layer and oral biofilm.

6. Conclusion

An emerging field such as nanotechnology has a significant potential to yield new generation of technologically advanced clinical tools and devices for oral health-care. It can act as an alternative and superior approach in assessment of the onset or progression of diseases, identification of the targets for treatment interventions as well as the designing of more biocompatible, microbe resistant dental materials, and implants. For all these things to happen, nanodentistry needs to overcome the various barriers or challenges for its application. Just like every coin has two sides, nanotechnology also carries a significant potential for misuse and abuse on a scale and scope never seen before. Due to insufficient evidence on potential hazards on human health and environment, nanotechnology has become a controversial issue.

References

[1]. Arora R, Kapoor H. Nanotechnology in Dentistry - Hope or Hype. OHDM 2014; 13(4):928-33
[2]. Rodgers P.Nanoelecronics:singlefile.Nature Nanotechnology 2006.
[3]. FreitasRA.Nanomedicine basic capabilities, George Town TX:Landes Bioscience: 1999,p345-47.

[4]. IMF Abiodun-Solanke, DM Ajayi, and AO Arigbede.Nanotechnology and its Application in DentistryAnn Med Health Sci Res. 2014 Sep-Oct; 4(Suppl 3): S171–S177.
[5]. Saravana KR, Vijayalakshmi R. Nanotechnology in dentistry. Indian J Dent Res. 2006;17:62–5.
[6]. Verma SK, Prabhat KC, Goyal L, Rani M, Jain A. A critical review of the implication of nanotechnology in modern dental practice.Natl J MaxillofacSurg 2010; 1(1):41-4.
[7]. Jan SM, Mir RA, Behal R, Shafi M, Kirmani M, Bhat MA. Role of Nanotechnology in Dentistry.Sch J App Med Sci 2014; 2(2D):785-9. [1] Arora R, Kapoor H. Nanotechnology in Dentistry - Hope or Hype. OHDM 2014; 13(4):928-33.
[8]. Pinon-Segundo E, Ganem-Quintanar A, Alonso-Perez V, Quintanar-Guerrero D. Preparation and characterization of triclosan nanoparticles for periodontal treatment. Int J Pharm 2005: 294: 217–232.
[9]. Kong LX, Peng Z, Li SD, Bartold PM. Nanotechnology and its role in the management of periodontal diseases. Periodontol 2000, 40: 184-196, 2006.
[10]. Catledge SA. Nanostructured Ceramics for Biomedical Implants. J nanoscience and nanotechnology 2002; 2(3-4):293-312.
[11]. Chesnutt BM, Viano AM, Yuan Y, et al. Design and characterization of a novel chitosan/nanocrystalline calcium phosphate composite scaffold for bone regeneration. J Biomed Mater Res. 2009;88(2):491-502.
[12]. Chesnutt BM, Yuan Y, Buddington K, Haggard WO, Bumgardner JD. Composite chitosan/nano-hydroxyapatite scaffolds induce osteocalcin production by osteoblasts in vitro and support bone formation in vivo.TissueEng Part A.2009;15(9):2571-257910. Chen HF, Clarkson BH, Sunk, Mansfield JF. Self assembly of synthetic hydroxyaptitenanorods into enamel prism like structure. J Colloid InterfSci 2005; 188:97-103.
[13]. Perwez E. Nanodentistry: A Beginning of a New Era in Dentistry. Indian Journal of Dental Education 2014; 7(1):9-15.
[14]. Ahmed W, St John Crean. Nanotechnology for tooth regeneration. Faculty Dental Journal 2014; 5(1):32-8. [3] Kaehler T. Nanotechnology: basic concepts and definitions. ClinChem 1994; 40:1797-9.
[15]. Colon G, Ward BC, Webster TJ Increased osteoblast and decreased Staphylococcus epidermidis functions on nanophaseZnO and TiO2. J Biomedical Mater Res..78(3):595-604, 2006.
[16]. Bhardwaj A, Bhardwaj A, Misuriya A, Maroli S, Manjula S, Singh AK. Nanotechnology in dentistry: Present and future. J IntOra Health 2013; 6(1):121-6. [5] Mala K. Mission possible. J Interdiscip Dentistry 2014; 4:109.
[17]. Freitas RA Jr. Nanotechnology, nanomedicine and nanosurgery. Int J Surg 2005; 3(4):243-6. [8]

* Neha Yadav. " Role of nanotechnology in advancement of periodontology." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) 16.8 (2017): 38-41