ORIGINAL RESEARCH PAPER

Periodontology

NANOTECHNOLOGY IN PERIODONTICS : A SURPRISE IN SMALL PACKET

KEY WORDS:
Nanotechnology,Nanorobotics, Periodontics application.

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ABSTRACT

Its in the history that goodness and greatness does not depend on size. With the advancement in science we are moving towards the era of small sized particle with great surprises in small packets . if we talk about robot it's a machine specifically designed to performs many tasks with precision at nano scale dimension.there is unlimited possibility and great potential of any basic particle ,on this basis nanodentistry will make it possible to maintain oral health through the help of nanomaterials, biotechnology, nanorobotics with precision and has created a boom in medical and dental field.The main aim of the present paper to mainly emphasise the contribution of nanotechnology in periodontics alomg with other fields.

INTRODUCTION:

Science is undergoing yet another change in helping mankind enter a new era, the era of nanotechnology. Nanotechnology era is fast approaching which was unheard of two decades ago. The current literature is often confusing when trying to understand what "nanosized" refers to because authors often wander back and forth across nano-, micro-, and macroconcepts in the same manuscript. To bring nanosized into perspective, Figure 1[1] shows the relative sizes of many body structures.

The prefix nano derives from the Greek word for "dwarf." Nano science refers to the science and discipline, and nanotechnology refers to the applied part of it including the engineering to control, manipulate, and structure the matter at an unimaginably smaller scale: nano scale. This scale is also referred to as "atomic" or "molecular" scale that is 100 nanometers or smaller. One nanometer (nm) equals to one-billionth of a meter, or about the width of 6 carbon atoms or 10 water molecules.

The narrowest definition of nanotechnology refers to the science of manipulation of single atoms, rather than groups of atoms, and as such is probably practiced by only a select few laboratories in theworld. A broader de nition of nanotechnology with far more relevant applications to the health sciences includes structures at the grouped atom level up to approximately 100 nm. The ability to control and manipulate materials at the level of atoms and molecules (with characteristic length scales of 1–100 nm) and integrating such exquisitely tailored materials within larger (micro- and macroscale) systems for engineering and medical applications are two of the de ning signatures of nanoscience and nanotechnology.

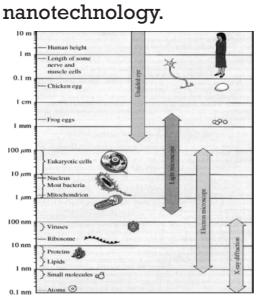

Figure 1.this Is A Diagram Illustrating The Relative Size Scale And Method Of Visualization Of The Discussed Structures.

From Liu H, Webster J. Nanomedicine for implants: a review of studies and necessary experimental tools. Biomaterials. 2007;28:354–369.

HISTORY :

The term 'nanotechnology' was first used by Norio Taniguchi in 1974, though it was not widely known. Inspired by Feynman's concepts, K Eric Drexler independently used the term 'nanotechnology' in 1986. Humans have been using nanotechnology for a long time without reali zing it. The processes of making steel, vulcanizing rubber and sharpening a dental instrument, all rely on manipulations of nanoparticles. Richard Zsigmondy studied nanomaterials in the early 20th century, and later discoveries culminated in ideas presented by Nobel Prize winning physicist, Richard Feynman in a lecture called 'Plenty of Room at the Bottom' in 1959, in which he explored the implications of matter manipulation.[2] Applications began in the 1980s with the invention of the scanning tunneling microscope and the discovery of carbon nanotubes and fullerenes.[3]

What Made Nanotechnology Possible?

Two achievements developed nanotechnology through the scientific method rather than conceptual; first, the invention of scanning tunneling microscope (STM) by Binnig and Rohrer in 1981, by which the individual atoms were easily identified for the first time. Some of the limitations of this microscope were eliminated through the invention of the atomic force microscope, which could image nonconducting materials such as organic molecules. This invention was integral for the study of carbon buckyballs, discovered at Rice University in 1985-1986 and carbon nanotubes few years later.[4]

Man's desire to create materials with better improved properties is ever lasting and still pursuing. Nanotechnology has an immense potential in fulfilling this desire; the properties of materials change drastically by just manipulating the way atoms or molecules are arranged.[4]

TECHNIQUES OF NANOTECHNOLOGY[5]

Top-down Technique These seek to create smaller devices by using larger ones to direct their assembly. Here, small features

are made by starting with larger materials patterning and carving down to make nanoscale structures in precise patterns. Complex structures containing hundreds of millions of precisely positioned nanostructures can be fabricated. Materials reduced to the nanoscale can suddenly show very different properties, enabling unique applications. As the size of system decreases, there is an increase in the ratio of surface area to volume and number of physical phenomena becomes noti ce ably pronounced which include statistical as well as quan tum mechanical effects.

Bottom-up Technique

These seek to arrange smaller components into more complex assembly. This begins by designing and synthesizing custom made molecules that have the ability to selfassemble or selforganize into higher order mesoscale or macroscale structures. Modern synthetic chemistry has reached the point where it is possible to prepare small molecules to almost any structure. These methods are used today to manufacture a wide variety of useful chemicals such as pharmaceuticals or commercial polymers. Such bottomup approaches are much cheaper than topdown methods, but could potentially be overwhelmed as the size and complexity of the desired assembly increases.

Nanomaterials

Siegel has classified nanomaterials as zero-dimensional, one-dimensional, twodimensional and threedimensional nanostructures.[6] Various nanostructures include the following:

- Nanoparticles
- Nanopores
- Nanotubes
- Nanorods
- Nanospheres
- Nanofibers
- Nanoshells
- Dendrimers
- Liposomes
- Fullerenes
- Nanowires
- Nanobelts
- Nanorings
- Nanocapsules
- Quantum dots
- Dendrimers and dendritic copolymers.
- Inorganic nanoparticles either currently in use or under development include:
- Semiconductor nanoparticles
- Metal nanoparticles
- Metal oxide nanoparticles
- Silica nanoparticles
- Polyoxometalates
- Gold nanocrystals.

Nanotechnology Use In Periodontics

Periodontitis is 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 patient.

NanoroboticDentrifices (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.[7] FIGURE2.

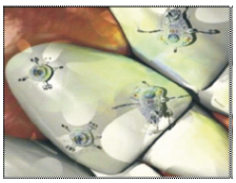

FIGURE 2: Dentifrobots

Dentin 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.[8]

Nanomaterials For Periodontal Drug Delivery:

The widely used nanomaterials for 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.[9]

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.[10]

Tetracycline incorporated into microspheres is available as Arestin for drug delivery by local means into periodontal pocket.[11]

Nanomaterials To Induce Bone Growth Bone :

It 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.[12] 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.[13,14]

Laser Plasma Application For Periodontium:

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]

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.[9,12] Deficient formation of bone around the biomaterial immediately after the implantation is the most common reason for failure of dental implant.FIGURE 3.The coating of nano particles over the dental implants, improves the adhesion and integration of surrounding tissues.[18]

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.[16]

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.[16]

Nanostructured metalloceramic coatings: These provide continuous variation from a nanocrystalline metallic bond at the interface to the hard ceramic bond on the surface.[16]

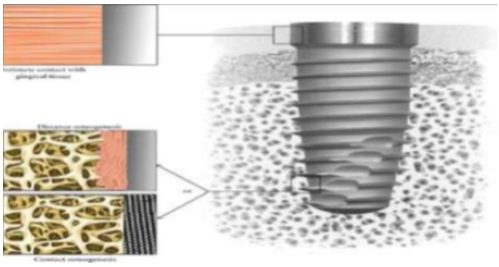

FIGURE 3: Nanosurface modification of Implants. Modifying surface roughness has been shown to enhance the bone-to-implant contact and improve their clinical performance.

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 microarchit ectural units of nano-rod like calcium hydroxapatite crystals arranged parallel to each other.[19]

CONCLUSION:

The impact of nanotechnology on the field of dentistry is creating drastic changes with respect to improvement of health, diagnosis, use of natural resources. Nanotechnology has had its greatest effect on periodontal aspect with the help of nanostructures, such as nanoparticles, nanotubes, nanorods, quantum dots, dendrimers, nanospheres, nanofibers, etc. Nanotechnology improves the understanding of the pathophysiologic basis of disease, conveys extra

refinements in diagnosis, and yields more efficient treatment and preventive properties. Overall we can conclude that , 'Future of nanotechnology is enhancing day by day,and it will be amazing'. With advancement of time ,resources and needs nanotechnology will deal a great path. These and other exciting future applications of manmade nanomachines will be limited only by our imagination.

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