Nanotechnology: A Dental Bonn

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Abstract:

Nanotechnology era is rapidly approaching which was muffled decades ago. All the aspects of human life will be influenced by progress made in nanotechnology in the near future. Origin of the word 'nano' is from the Greek word "dwarf". The concept of nanotechnology was introduced by Richard Feynman first, in 1959, a Nobel Prize winning physicist. His lecture was tittled, "There's plenty of room at the bottom". And concluded by saying "this is a development which I think cannot be avoided".

James Clerk Maxwell in 1867, proposed an uprising concept of nanotechnology. In the times where, the whole world was trying to make things bigger and bigger, he foresaw submicroscopic machines with the ability to handle individual atoms and molecules. He called these Maxwell's demons, which are now famously known as 'Nanorobots'.

The term "Nanodentistry" was coined by R.A. Freitas Jr., in 2000. He invented the use of nanorobots for orthodontics, dentition regeneration, nanomaterials, and robots in dentifrices dentifrobots.

Synthesis of Nanoparticles:

Synthesis of nanoparticles is mainly done using two approaches. Based on how the molecules are assembled to achieve the desired products they are classified as:

- TOP DOWN
- BOTTOM UP

The top–down technique starts with taking a macroscopic material (the finished product) and then engaging them with smaller scale details into it. The molecules thus form, rearrange themselves to get the desired property. This approach is still not used widely as many of the devices used to operate at nano level are still under-development.

The bottom–up approach follows the principal of self-replication. Specially designed and synthesized custom made molecules have the ability to self-replicate. The molecules are then operated to organize themselves into higher macro-scale structures. The molecules self-replicate by the changes observed by them in specific physical or chemical property that triggers the self-replication. This can be any change in, pressure, temperature application of electricity or a chemical. The self-replication of molecule has to be carefully managed so it does not go out of hand.

Nanorobotics:

Nanorobotics, it is a science of making machines or robots at or close to the microscopic scale of nanometers. According to various theories put forward, one of the theory, 'nanorobots are microscopic in size, it would probably be necessary for very large numbers of them to work together to perform microscopic and macroscopic tasks. These robots have ability to very well differentiate between cell types by identifying their surface antigens. Once, the work of these nanorobots is done they themselves exfuse via human excretaory channels, this is how they are retrived.

Nano Technology in dentistry:

Orofacial fain management: In this, dental nanorobots are designed to use specific motility mechanisms to swim through human tissue with navigational precision, sense and manipulate their surroundings ,acquire energy and achieve safety to penetration. The dentist may issue specific set of instructions by transmitting orders directly to in vivo nanorobots using acoustic signals or some other means. Here, they have shown promising results in treating MPDS, Trigeminal Neuralgias, early cancer detection.

Local nanoanaesthesia: In this technique patient's gingiva will be instilled by a colloidal suspension solution containing millions of active analgesic micron-size dental robots. The circulating nanorobots will reach the pulp via the gingival sulcus, lamina propria and dentinal tubules by contacting the surface of tooth (crown) or mucosa. Once these reach the pulp, the analgesic dental robots then can be commanded by the dentist to manage all the sensitivity in the particular tooth that requires treatment.

Impression materials: Nanofillers are combined with vinyl polysiloxanes, producing a special addition of siloxane impression materials. The material thus form, have excellent flow for the detailed impression, unique hydrophilic properties and improved precision.

Implants: For faster and better osseointegration of implants, nanotechnology has showed excellent results. Understanding and controlling reaction at nano level has led to production of excellent implants. Local dose of anti-inflammatory agents present then gradually get released from coatings on the surface of implanted device.

Orthodontic nano-robots could reduce the orthodontic realignments in a single office visit. By the use of this technology,

the nanoparticles directly employs the periodontal tissues, permitting fast and painless tooth straightening, rotating and vertical repositioning within minutes to hours. Optiflex impregnated with nano composite materials is game changer in orthodontics.

Recently, In periodontal point of view scientists have produced and characterized triclosan loaded nanoparticles by the emulsification diffusion process, with the intention to obtain an ideal delivery system required for the treatment of periodontal disease. A homogeneous polymer matrix-type delivery system, with the drug molecularly dispersed is present in triclosan nanoparticles. An example is Arestin in which tetracycline is incorporated into microspheres for local drug delivery to a periodontal pocket.

Nanocomposites: By using nanotechnology, the production of nano-dimensional filler particles is seen, which are added either singly or as nanoclusters into composite resins. This allows the production of nano-sized filler particles which can be added in greater amounts into the composite resin matrix unlike traditional fillers.

Nanosolution: Nanosolution can be used in bonding agents, as they produce a unique and dispersible nano-particle which helps to get the desired results (trade name: Adper Single Bond Plus Adhesive single Bond).

Nanotechnology for Prevention of Dental Caries: The use of a toothpaste containing nanosized calcium carbonate enabled remineralization of early enamel lesions which is a bonn in dentistry itself.

Tooth Durability and Appearance: Replacing the upper enamel layers with covalently bonded artificial materials such as sapphire or diamond can improve the durability and appearance of tooth may, which have 20-100 times the good biocompatibility and hardness and failure strength of natural enamel or contemporary ceramic veneers.

Nanotechnology is anticipated to change health care in a fundamental and clinical way. The Foresight Institute has offered the $250,000 Feynman Grand Prize to the first researcher or researchers who develop two devices:

- A Basic Nanorobot
- A Nanocomputer.

Christine Peterson, president of the Foresight Institute, approximates that the prize will be claimed between 10 and 20 years from now. Because the initial nanodevices will be basic, prototypical units, commercial applications will follow years later.

Nanodentistry still faces many landmark to compete and also in realizing its immense potential. Some common hurdles on the way include basic engineering problem from accurate placement and assembly of molecular-scale parts to economical mass production techniques to biocompatibility and the simultaneous coordination of the activities of large number of independent micrometer-scale robots.

Many promising research activities are being carried out throughout the world with the intention of changing the diagnosis and treatment planning in dentistry. Moreover, various studies on tissue regenerative materials, tissue engineering is carried out for improving the esthetics in the field of dentistry.

We are looking forward to a favorable future with nantechnology in all the dental fields.

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