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Dentistry at the Nano Level!!!

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Abstract: *A new advancing field has been under development for the better diagnosis and treatment in the field of dentistry which is called Nanodentistry. This technology may also help in the preventive, restorative and curative procedure in the future. It may also provide early diagnosis and superior approach to assess the onset and progression of the disease. This is a review article based on nanotechnology and its uses in dentistry.*

Keywords: *Nanotechnology, nanocomposite, nanorobots, nanodiagnosis.*

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I. Introduction

Researchers have predicted that high technology and effective management at the microscopic level, termed nanotechnology, will become an important part of the future dental and periodontal health and treatment. Nanotechnology, has been achieved by manipulating matters at the atomic level, is measured in nanometers, roughly the size of two or three atoms. Some researchers believe that nanotechnology is a scientific evolution that developed in the late 1980s, evidence leads that nanotechnology has been used since the late 1959. Some believe that humans have unknowingly used nano technological methods for many years, perhaps even longer. However, nanotechnology is still new, providing a new field for scientific research [1].

One of the first concepts mentioned is nanotechnology (but predating the use of that name) was in 1867. In 1867, James Clerk Maxwell proposed, as an experiment, a tiny entity known size measurements of nanoparticles were made during the 20th century by Zsigmondy. Richard Feynman, a physicist in 1959, in his remarkable lecture ‘‘There’s Plenty of Room at the Bottom’’ he had concluded that ‘This is a development which I think cannot be avoided’. Four decades ago, the use of single atoms and molecules seemed illusive; however, he said that the time would inevitably come when the atomically manipulation of matter would be possible in the near future.

Nanotechnology is a technology that deals with structures ranging from size 100 nm or smaller. The term ‘nanotechnology’ was first used in 1974 by Norio Taniguchi in the University of Tokyo. The term ‘nano’ is derived from Greek word which means ‘‘dwarf”.

A new field called nano dentistry was formed due to the rising interest of nanotechnology and its application. These include local anaesthesia, dentition renaturalization, and permanent cure of hypersensitivity, complete orthodontic treatment, covalently bonded diamondized enamel, and continuous oral health maintenance.

Dental nanorobots may use particular motility mechanisms to infiltrate human tissue with navigational precision, which require energy, and sense and manipulate their surroundings in real time. An on board nano computer that performs pre-programmed instructions in reaction to local sensor stimuli could be employed to control the nano robot functions .Also ,the dentist could issue planned orders directly to the nanorobots in vivo via auditory signals. Dental views for nanorobots identified by former researchers[2] have included the combination of atomic elements to construct nano particles and the construction of mechanical nanoscale objects.

Application of nanotechnology in diagnosis and treatment:-

1. Nano diagnostics:-

With the help of nano technology these devices can scan and be used for early disease identification at the cellular and molecular levels. Nanomedicine could increase the efficiency and dependability of in vitro diagnostics, through the use of selective nano devices to accumulate human fluids, or tissue samples and to make multiple analyses at the sub-cellular level. From an in vivo view, nanodevices might be introduced into the body to recognise the early presence of a disease, or to detect and quantify toxic molecules, tumour cells [3].

2. Detection and treatment of oral cancer:-

Saliva is used as a sample and non-invasively obtained diagnostic medium that contains proteomic and genomic markers for molecular disease detection. Exosome, a membrane-bound secretory vesicle, is one such marker whose level is raised in malignancy. This marker has been studied via atomic force microscopy, which employs nanoparticles. The nanoscale cantilevers, nano pore, nano tubes, quantum dots, lab-on-a-chip, nano electromechanical systems (NEMS), oral fluid nano sensor test (OFNASET) and optical nano biosensor are used to diagnose oral cancer and other diseases. Nano shells, which are miniscule beads, are particular tools in cancer therapeutics. Nano shells have an external metallic layer that selectively terminates cancer cells, while normal cells are left unharmed. Brachytherapy is an advanced form of cancer treatment. Still under trial are nanoparticle-coated, radioactive sources positioned close to or within the tumour to terminate it [4].

3. Nanoanesthesia

When anaesthesia is given using nano technology , the gingiva of the patient is in stilled with a colloidal suspension comprising millions of active, analgesic, micron-sized dental robots which respond to input supplied by the dentist. Nanorobots in communication with the surface of the crown or mucosa can reach the pulp through the gingival sulcus, lamina propria, or dentinal tubules. Once in the pulp, they shut down all sensations by creating a control over nerve-impulse traffic in any tooth that requires treatment. After the end of treatment, they re-establish the sensation, thereby providing the patient with anxiety-free and needle less comfort. The anaesthesia is fast-acting and reversible, with no side effects or complications associated with its use [5].

4. Nano solutions

Nano solutions can be used as bonding agents. Homogeneity is ensured, because the adhesive is mixed perfectly every time. Nano solutions can be added to various solvents, paints and polymers. Nanoparticles have also been used as sterilizing solutions [6].

5. Impression materials

Nano fillers are incorporated into vinyl poly siloxanes, fabricating a unique siloxane impression material that has a better flow, enhanced hydrophilic properties, and higher precision detail. These materials have resistance to distortion, high tear resistance, instant set and heat resistance [7].

6. Bone replacement materials

Nanotechnology aims to imitate the natural structure for orthopaedic and dental applications and mostly, for the development of nano bone. Nanocrystals showed an unattached microstructure, with nano pores located between the crystals. The exteriors of the pores are adapted such that they adsorb protein, due to the addition of silica molecules. Bone defects can be treated by using these hydroxyapatite nanoparticles [8].

7. Nano encapsulation

Targeted release systems that incorporate nano capsules are under trial for inclusion in vaccines, drugs and antibiotics with reduced side effects. In 2003, the Osaka University has developed the targeted delivery to genes and drugs to human liver. In the future this targeted release system can be applied in oral tissues including cell derived from the periodontium [9].

8. Dentin hypersensitivity

Hypersensitivity is caused by deviations in the pressure transferred hydro dynamically to the pulp. Hypertensive tooth have twice the diameter and eight times the surface density of dentinal tubules than those in non-sensitive teeth. These characteristics have led to construction of nanorobots that selectively and precisely seal tubules in minutes, by using local, native materials, thus offering patients a rapid and lasting relief [10].

9. Nano robotic dentifrices or dentif robots

Nanorobotic dentifrices, when transported either by mouthwash or toothpaste, can shield all subgingival and supra gingival surfaces, thereby metabolizing imprisoned organic matter into harmless and odourless vapours. Properly configured dentif robots can detect and extinguish pathogenic bacteria that exist in the plaque and elsewhere. These invisibly small dentif robots are only mechanical devices that safely neutralize themselves when swallowed[11].

10. Orthodontics

Orthodontic nano robots allow painless tooth up righting, rotating, and vertical relocation, as well as fast tissue repair. Hence, this offers advantages over the up righting of the molar that require weeks and months. A new stainless-steel wire that uses nanotechnology is being studied that combine ultra-high strength with good deformability, corrosion resistance, and surface finish [12].

11. Nano needles

Nano sized stainless-steel crystals combined into suture needles have been developed. Cell surgery may be imaginable in the near future with nano tweezers, which are now underdevelopment [13].

12. Nanocomposites

The filler particle size cannot be reduced below 100nm, nanocomposite particles are minute adequate to be synthesized at the molecular level. These nanoparticles advance the compressive strength of the material. Filler particles of submicron size, such as zirconium dioxide, a real so necessary to increase polish ability and aesthetics. Conversely, when particles of this size are used, the material may be more susceptible to brittleness and cracking or fracturing after curing. To this issue, hybrid composites and composites comprising a widespread distribution of filler particles have come into use. Although these composites show an improved balance of strength and aesthetics, they are fragile due to nanoparticle clattering or agglomeration. This problem can be overwhelmed by including a proprietary coating process during the particles developing procedure, there by eradicating fragile spots and providing reliable strength throughout the entire ‘‘fill’’ of the core build-up. Moreover, the even delivery of nanoparticles results in a smoother, creamier consistency and increases flow characteristics. When the material is cured to its hardened state, these properties contribute to the dentin like cut ability and polish ability of the material [14].

13. Major tooth repair/nano tissue engineering

Replacement of the complete tooth, comprising the cellular and mineral components, is called as complete dentition replacement. This therapy is possible through a mixture of nanotechnology, genetic engineering, and tissue engineering. Complete dentition replacement was the basis for research by Chan et al., who reconstructed dental enamel, the hardest tissue in the human body, by using extremely planned micro architectural units of Nano rods [15].

14. Dental implants

Nano alteration of titanium implants that promote successful Osseo integration and the factors responsible are surface contact area and surface topography. However, bone bonding and stability also play a role. Bone growth and better predictability can be well expedited with implants by using Nano technology. Nano-structured implants coating that have been developed are nanostructured diamond, nanostructured hydroxyapatite coatings, and nanostructured metallic ceramic coatings. Research on the effects and resulting optimization of micro topography and surface chemistry has formed enhanced strides in material engineering. These new implants are more adequate, because they improve the integration of Nano coatings similar to the biological materials to the tissues [16].

II. Conclusion

The use of nanotechnology is still new in the field of dentistry and challenging. There are still conflicting views remain concerning the use of nano robots in vivo. These views need to be cleared before nanotechnology can be combined into the armamentarium used in clinical practice. Hope that nanotechnology advances in the years to come which may ease the work of the practitioner in diagnosis and treatment [17,18].

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