**TINY MIRACLE WITH ENORMOUS POTENTIAL – NANOBOTS**

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**ABSTRACT**

**Dental nanobots were first introduced by Robert Freitas in 1994. The manipulation of matter at the molecular and atomic levels is known as nanotechnology. It has the potential to revolutionize the domains of medicine and dentistry. Nanodentistry may soon be able to maintain near-perfect dental health with the help of nanorobotics, nanomaterials, and biotechnology. However, like with any breakthrough, there is a possibility of misuse. Time, economic and technological resources, and human needs will all influence the course of this revolutionary growth. This article examines the current state of nanotechnology, nanaomedicine, and nanodentistry, as well as their future therapeutic applications.**

**KEYWORDS: NANOROBOTS, NANODENTISTRY , DENTIFIROBOTS, NANOMEDICINE, FUTURE APPLICATIONS.**

**INTRODUCTION**

Nanorobotics is the technology of creating machines or robots at

or close to the microscopic scale of a nanometer (10–9 meters).

 The growing interest in the application of nanotechnology in dentistry is leading to the emergence of a new field called nanodentistry. In fact, a new area of technical study that uses nanotechnology for creating and building nanorobots will be crucial to the fields of medicine and dentistry.

 There are countless uses for nanorobots, with dental applications being the most fascinating. In order to achieve safe cytopenetration in real time, certain processes can be created, such as the ability to swim or crawl through human tissue with navigational accuracy to acquire energy. Dental nanorobots will have a significant positive impact on oral health, enabling rapid, painless, and precise dental procedures.

 Recent advances in the field of nanorobots prove that nanodentistry has strong potential to revolutionarize dentistry to diagnose and treat diseases.

**PRINCIPLES OF NANOROBOTS**

1. Powering- It accomplishes this by metabolizing carbohydrates, oxygen, and externally provided acoustic energy. Onboard computers often control it.

2. Communication- Acoustic signals and a navigational network established in the body provide communication. It keeps track of numerous bodily gadgets and interacts with the dentist.

3. Excretion- Once it has finished its task, it is generally recovered when it effuses itself through the human excretory pathways.

**MANUFACTURING DONE BY TWO TYPES OF NANOBOTS**

Two approaches for manufacturing medical nanorobots are suggested according to researcher Adriano Cavalcanti from the Center for Automation of Nanobiotech (CAN) in Brazil.

 1. Organic nanorobots (Also known as bionanorobots): Manufactured using proteins and polynucleotides.

2. Inorganic nanorobots: Manufactured using metals or diamonds.

 Metals have double benefit

 Ex: silver serve as the base of a nanorobot and has an antibacterial effect. Diamond - has high strength h and high performance.

**In dentistry, nanorobots are gaining importance via**

• Bring about oral analgesia

• Tooth desensitization

• Manipulating the tissue to realign and straighten irregularly arranged teeth

• To enhance the durability of teeth

• Also employed to do preventive, restorative, curative procedures

i.e., Dental nanorobots could be used to kill caries-causing bacteria or to repair tooth blemishes where decay has developed, by employing a computer to direct these tiny workers in their tasks.

**ORAL HYGIENE AND HALITOSIS** :

 Nanorobotic dentifrice is mainly kept sub occlusally (dentifrobots) These dentifrices monitor the supragingival and subgingival surfaces for a minimum of once a day and destroy pathogenic bacteria in plaque and food.

 Nanoscale particles are incorporated to conventional dentifrices such as mouth rinses and toothpastes to aid in:

 Repelling the deposition of bacterial biofilm;

 Preventing early remineralization of carious lesions; and

 Assisting in the deposition of minerals lost by teeth, known as enamel remineralization.

Silver nanoparticles and triclosan-loaded nanoparticles are the most common nanoparticles found in dentifrices.

**MANAGEMENT OF DENTINAL HYPERSENSITIVITY**

 The most commonly faced dental problem by the patients is Dentinal hypersensitivity which is another area where Nanorobots are useful. Nanorobots are utilized to selectively and precisely occlude tubules in minutes, by making use of native biologic material, thus benefiting the patients with a rapid and permanent cure.[2]

 The choice of material is Nanohydroxyapatite (n-HAP). It is gaining importance in the field of dentistry, mainly ascribed to its structural similarity to the crystals of the tooth enamel, and is a biocompatible and bioactive material.

n- HAP-containing toothpaste was found to be advantageous in decreasing dentin hypersensitivity and can be prescribed for dentinal hypersensitivity management. Wang et al in their study reported that nano-hydroxyapatite formulations (with or without home-care product association) were as effective as the other treatment approaches in decreasing dentin hypersensitivity[3].

**NANOANESTHESIA :**

 A colloidal suspension containing millions of active analgesic microns to which dental nanorobots particles are infused on the patient’s gingiva. Once they lie in proximity to the mucosa or crown, the ambulating nanorobots reach the dentin, by migrating into the gingival sulcus and passing painlessly to the lamina propria or through a 1-3 micrometer thick layer of loose tissue at the CEJ. On reaching the dentin, nanorobots enter the dentinal tubules up to 1-4micron depth and move towards the pulp directed by a combination of chemical gradients, temperature differentials, and even positional navigation, all under the control of a nanocomputer as guided by the dentist. Time taken for nanorobots to reach the pulp from the tooth surface is approximately 100 seconds thereby giving a quick relief of sensitivity.

 i.e., Tooth surface ---100 seconds --------------------------pulp

Upon reaching the pulp, they are given an order by the dentist to shut down all the sensations of that particular tooth that requires treatment. Once the procedure is completed, the dentist orders the robots to reinstate all the sensations.

Advantages

 Renders better and speedy action

Reduced patient anxiety as it doesn’t use needles

 Reduced adverse effects/complications of local anesthesia.

 Anesthetic effect is fast and completely reversible thus offering both patient and dentist comfort.

**SURGICAL NANOROBOTICS:**

A surgical nanorobot coded or led by a dentist might function as a semiautonomous on-site surgeon within the human body. A device of this type might perform a variety of duties, such as looking for disease and then detecting and treating defects using nanomanipulation, all while communicating with the supervising surgeon through coded ultrasonic signals.

The first versions of cellular nanosurgery are already being researched. A fast vibrating (100 Hz) micropipette with a 1 micron tip diameter, for example, has been used to entirely remove dendrites off single neurons without compromising cell survival.

Femtosecond laser surgery was used to conduct axotomy on roundworm neurons, following which the axons functionally recovered. A femto laser functions similarly to a pair of lasers by vaporizing tissue locally while using 'nanoscissors'.

**BONE REPLACEMENT MATERIALS**:

Used in maxillofacial injuries requiring bone graft, cleft patient

and osseous defect in periodontal surgeries.

 Hydroxyapatite nanoparticles used to treat bone defects are

 Ostim® (Osartis GmbH & Co KG, Obernburg, Germany) HA.

 VITOSSO (Orthovita, Inc., Great Valley Parkway Malvern,

 PA 19355, USA) HA and TCP.

 NanOSSTM (Angstrom Medica, USA) HA.

 **LOCAL DRUG DELIVERY:**

Local administration of drugs improves the regeneration potential of damaged tissues and aids in the treatment of periodontal disease. These provide therapeutic compounds that can be put into carriers such as scaffolds to enable for regulated and sustained release. The prolonged release of the medication into the periodontal pocket improves drug concentration. The items utilized for medication administration are :

 Nanoparticles: TRICLOSAN nanoparticles, MINOCYCLINE nanoparticles, CALCIUM LOADED nanoparticles, ZINC LOADED nanoparticles

 Nanogels: introduce quantum dots to PDL cells

 Nanofibers: Poly e-caprolactone containing metronidazole [4]

 **NANONEEDLES**

Nanosized stainless-steel crystals incorporated into suture needles have been developed. Cell surgery may be possible in the near future with nanotweezers, which are now under development.

 **NANOCOMPOSITES**

Microfillers have long been used in composites and microcore materials. Although the particle size of the filler cannot be lowered below 100 nm, nanocomposite particles are small enough to be manufactured at the molecular level. These nanoparticles increase the material's compressive strength. Submicron filler particles, such as zirconium dioxide, are also required to increase polishability and esthetics. However, when this size of particle is employed, the material may be more brittle and prone to cracking or fracturing after curing.

To overcome this problem, hybrid composites and composites with a more even dispersion of filler particles have been developed. Although these composites have a higher strength-to-esthetics ratio, they are weak due to nanoparticle clumping or agglomeration.

 This issue is solvable addressed by introducing a special coating technique throughout the particle production method, so removing weak areas and giving uniform strength across the core build-up's complete "fill" In addition, uniform nanoparticle dispersion produces a seamless, more luxurious consistency and enhances flow properties.

Once the material has solidified, these qualities contribute to the material's dentin-like cutability and polishability.

 **POTENTIAL FUTURE APPLICATIONS**

Dentifrobots are nanorobots that detect and remove dangerous oral bacteria while also preventing putrefaction, hence preserving a healthy oral ecology and reducing halitosis. They are typically composed of nanosized hydroxyapatite molecules that are given by mouthwash or toothpaste and can be destroyed if the patient inadvertently consumes them.

Dentin hypersensitivity is a rather common condition caused by pressure changes that are hydrodynamically conveyed to the pulp. A hypersensitive tooth's dentinal tubules are twice the diameter and have eight times the surface density of a non-sensitive tooth.

The fundamental treatment strategy for dentin hypersensitivity involves blocking open dentinal tubules, preventing external stimuli from causing fluid movements that cause discomfort. Dental nanorobots can recognize teeth and plug dentinal tubules in minutes by Utilizing indigenous biologic substances, patients can have a quick and long-lasting cure.

**ADVANTAGES & DISADVANTAGES OF NANOROBOTS**

 1. Nanorobotics is evolving rapidly progressively in the medical field owing to their effectiveness, and comfort, simultaneously lowering the risk and invasiveness significantly.

 2. Nanorobotics will help in the early diagnosis or prevention or management of the disease.

 Despite their varied applications and numerous advantages, nanorobots have challenges and risks.

**DISADVANTAGES.**

1. Expensive initial design.

2. Difficult to Interface, Customize, and has a complicated design

3. Electrical nanorobots are vulnerable to electrical interference from external sources such as radiofrequency(rf) or electric fields, electromagnetic pulse (EMP), and stray fields from other in vivo electrical devices.

**CONCLUSION :**

Nanotechnology is a foreseen future in which dentistry and periodontal practice become more high-tech and efficient in managing individual dental health. Nanorobotics research is still in its early stages, but it has the most promising future in dentistry.

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