TINY MIRACLE WITH ENORMOUS POTENTIAL – NANOBOTS

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, Nan dentistry, Dentifirobots, Nanomedicine, Future Applications.

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I. INTRODUCTION

The science of building devices or robots at or near the minuscule size of a nanometer (10–9 meters) is known as nanorobotics. A new field termed nanodentistry is emerging as a result of increased interest in using nanotechnology in dentistry. 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.

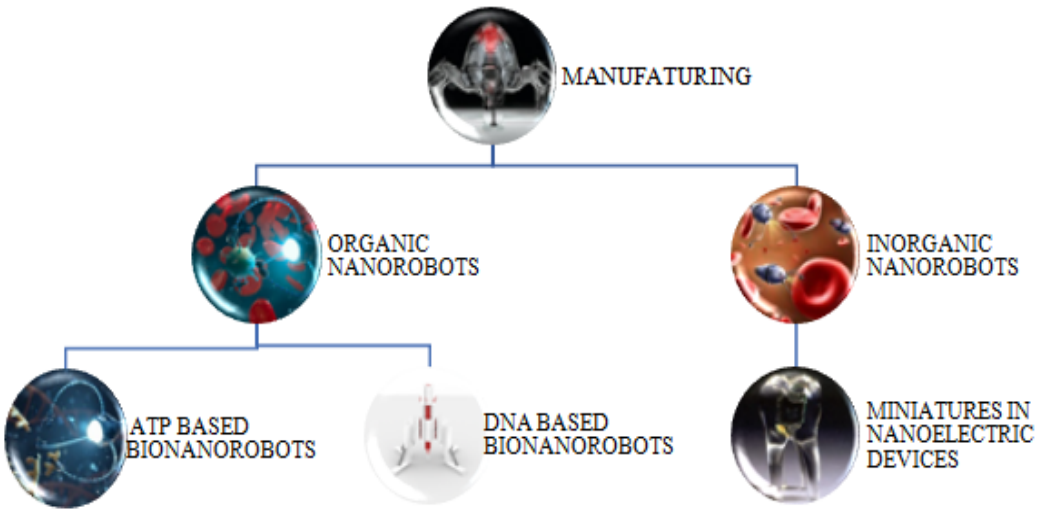
There are countless uses for nanorobots, with dental applications being the most fascinating. In order to achieve safe cytopenetration in real time, certain processes can be created, such as the ability to swim or crawl through human tissue with navigational accuracy to acquire energy. Dental nanorobots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

The science of nanorobotics has made significant strides recently, demonstrating the potential for nanodentistry to transform the way dentistry treats and diagnoses patients.

II. PRINCIPLES OF NANOROBOTS

- Powering- It accomplishes this by metabolizing carbohydrates, oxygen, and externally provided acoustic energy. Onboard computers often control it.
- 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.
- Excretion- Once it has finished its task, it is generally recovered when it effuses itself through the human excretory pathways.

III. 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.

- Organic nanorobots (Also known as bionanorobots): Manufactured using proteins and polynucleotides.
- 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
- Using tissue manipulation to realign and straighten teeth that are not evenly spaced
- To enhance the durability of teeth
- Also employed to do preventive, restorative, curative procedures

i.e., Dental nanorobots could be utilized to eradicate bacteria that cause dental cavities or to fix tooth imperfections where decay has occurred. These small workers would be guided by a computer to accomplish their tasks.

IV. ORAL HYGIENE AND HALITOSIS

Nanorobotic dentifrice, known as dentifrobots, is primarily located beneath the occlusal surface. These tiny robots are responsible for daily surveillance of both supragingival and subgingival surfaces, effectively eliminating pathogenic bacteria present in plaque and food.

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

- Preventing the accumulation of bacterial biofilm;
- Preventing early remineralization of carious lesions; and
- Facilitating the restoration of lost minerals in teeth, a process referred to as enamel remineralization.
- Silver nanoparticles and triclosan-loaded nanoparticles are the most common nanoparticles found in dentifrices.

V. MANAGEMENT OF DENTINAL HYPERSENSITIVITY

The most commonly faced dental problem by the patients is Dentinal hypersensitivity which is another area where Nanorobots are useful. By using native biologic material, nanorobots can accurately and selectively occlude tubules in a matter of minutes, providing patients with a quick and long-lasting treatment. [2]

A substance called nanohydroxyapatite (n-HAP) has been selected. Because of its structural resemblance to the crystals of tooth enamel and the fact that it is a biocompatible and bioactive material, it is becoming more and more significant in the field of dentistry.

Toothpaste that contains HAP has been shown to be helpful in reducing dentinal hypersensitivity and is therefore recommended for the treatment of dentinal hypersensitivity. Wang et al. found that in reducing dentin hypersensitivity, nano-hydroxyapatite formulations, whether or not they included a home-care product association, were just as successful as the other treatment modalities. [3].

1. **Nanoanesthesia:** A colloidal suspension applied to the patient's gingiva that contains millions of active analgesic microns and dental nanorobot particles. The ambulating nanorobots migrate into the gingival sulcus and pass painlessly through the lamina propria or through a layer of loose tissue that is 1-3 micrometers thick at the CEJ to reach the dentin once they are in close proximity to the mucosa or crown. When the nanorobots reach the dentin, they enter the tubules up to 1-4 microns below the surface. From there, they go toward the pulp under the guidance of a dentist-controlled nanocomputer, using a variety of stimuli including as temperature variations, chemical gradients, and even positional navigation. Nanorobots can quickly relieve sensitivity because it takes them around 100 seconds to travel from the tooth's surface to the pulp.
   i.e., Tooth surface ---100 seconds ----------pulp

   When they get to the pulp, the dentist gives them the instruction to block off all of the tooth's sensations that need to be addressed. The dentist gives the robots instructions to restore all of the feelings after the procedure is over.

   Advantages:
   - Improves and expedites action
   - Decrease in patient anxiety due to the lack of needles
   - Reduced harmful effects/complications of local anesthetic.
   - The quick and total reversibility of the anesthetic effect provides comfort for the patient as well as the dentist.

2. **Surgical Nanorobotics:** A surgical nanorobot that is guided or controlled by a dentist could function as an in-situ, semi-autonomous surgeon inside the human body. This kind of technology might be used for many other tasks, like scanning for illness and then employing nanomanipulation to discover and treat flaws, all the while interacting with the supervising surgeon via coded ultrasonic signals.

   The earliest forms of cellular nanosurgery are presently being investigation. Dendrites on individual neurons have been completely removed using a fast vibrating (100 Hz) micropipette with a 1 micron tip diameter, for example, without endangering the survival of the cells.

   Femtosecond laser surgery was used to conduct axotomy on roundworm neurons, following which the axons functionally recovered. Using "nanoscissors," a femto laser vaporizes tissue locally in a manner akin to that of two lasers.

3. **Bone Replacement Materials:** Used in cleft patients, osseous defects in periodontal procedures, and maxillofacial traumas necessitating bone grafting.

   Ostim® (Osartis GmbH & Co KG, Obernburg, Germany) HA, VITOSSO (Orthovita, Inc., Great Valley Parkway Malvern, PA 19355, USA) HA, and TCP, as well as NanOSSTM (Angstrom Medica, USA) HA, are hydroxyapatite nanoparticles used to treat bone deformities.

4. **Local Drug Delivery:** The localized delivery of drugs enhances the regenerative capacity of injured tissues and contributes to the management of periodontal disease. These substances consist of therapeutic compounds that can be incorporated into carriers like scaffolds, facilitating controlled and sustained release. This extended release of medication within the periodontal pocket enhances the concentration of the drug. The components utilized for drug administration include:

   TRICLOSAN, MINOCYCLINE, CALCIUM LOADED, and ZINC LOADED nanoparticles are among the nanoparticles. Neogengels: Including quantum dots in PDL cells can Metronidazole-embedded poly e-caprolactone nanofibers *[4]

VI. NANONEEDLES

Nanoscale stainless-steel crystals have been integrated into suture needles as part of ongoing advancements. The development of nanotweezers is currently in progress, potentially paving the way for cellular surgery in the near future.

VII. NANOCOMPOSITES

Micro fillers have long been used in composites and microcore materials. Nanocomposite particles are small enough to be produced at the molecular level, even though the filler's particle size cannot be reduced below 100 nm. The material's compressive strength is increased by these nanoparticles. It's also necessary to add submicron filler particles, such zirconium dioxide, to improve polishability and aesthetics. The material may be more brittle and prone to breaking or cracking after curing if this size of particle is used, though.

Hybrid composites and composites with a more uniform filler particle dispersion have been developed as solutions to this issue. These composites are weak because of nanoparticle clumping or agglomeration, even though they have a better strength-to-esthetics ratio.

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.

VIII. POTENTIAL FUTURE APPLICATIONS

Dentifrobots are a kind of nanorobots that lessen halitosis and maintain a healthy oral ecology by identifying and eliminating harmful oral bacteria and preventing putrefaction.

Usually found in mouthwash or toothpaste, they are made up of nanosized hydroxyapatite molecules, which the patient may accidentally swallow and destroy.

A relatively common disease called dentin hypersensitivity is brought on by pressure changes that are hydrodynamically transmitted to the pulp. Dentinal tubules in a hypersensitive tooth have eight times the surface density and twice the diameter of those in a non-sensitive tooth.

Dentin hypersensitivity is mostly treated by closing open dentinal tubules, which stops fluid movements brought on by outside stimuli from being uncomfortable. By using native biologic materials, dental nanorobots can identify teeth and seal dentinal tubules in a matter of minutes, providing patients with an efficient and long-lasting treatment.

IX. ADVANTAGES & DISADVANTAGES OF NANOROBOTS

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

- Expensive initial design.
- Difficult to Interface, Customize, and has a complicated design
- Electrical nanorobots are susceptible to external electrical interference, including electromagnetic pulses (EMP), stray fields from other in vivo electrical devices, radiofrequency (rf) or electric fields.

X. CONCLUSION

Future dental and periodontal practices are expected to become more advanced and effective at controlling each patient's unique oral health thanks to nanotechnology. Although research on nanorobotics is still in its infancy, dentistry appears to be the most promising use for it.

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