

Nanorobotics in Dentistry - Periodontal Point of View

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Abstract: *Nanorobotics in dentistry has a wide range of applications and the purpose of nano dentistry is most prevalent in periodontics. Nanorobotics is mainly a treatment-oriented technology where the application of it in periodontal aspect is wide. Dental nanorobots are constructed to destroy bacteria and help to repair the tooth. It can also stop the progress of infections. It uses a specific motility mechanism to crawl or swim through the human tissue and also manipulates the surroundings. Research into nanorobotics is still in its primary stage. So, the study selection has not been widely accepted and done in the field of dentistry. This article will give you various insights in nanorobotics, its principle of movement and how it can be used mainly in the field of periodontics.*

Keywords: nanorobots, periodontal nanorobots, dentifrobots, local drug delivery, quantum dots, halitosis

1. Introduction

There are different periodontal instruments used in dentistry. In the past, Albucasis was the first person who gave outstanding contributions to periodontics. He also gave a clear idea about the etiology of calculus and also gave excellent techniques and instruments for scaling. Later in 18th century, Faucher gave 5 sets of instruments that can be used in dentistry for scaling. In the present, there is so much advancement that we started using sonic and ultrasonic scalers for scaling and root planing. When we think about what future holds for us, we realize that there is going to be revolutionary changes in the patient's oral hygiene. So, the future of dentistry is all about how dentists utilize nanorobots to give patients a very good smile.

2. Nanorobotics and history

Nanorobotics or nanotechnology is science and engineering involved in design, synthesis, characteristics and application of materials and devices. They are usually measured in the scale of nanometers. They react at molecular level. The concept of nanotechnology was first introduced by Richard Feynman. The dental nanorobots were first introduced by Robert Freitas in 1994. ([1])

Parts:

The parts of nanorobots include:

- **CAMERA:** for the operator to witness what is occurring
- **PAY LOAD:** contains drug dose
- **CAPACITOR:** Energy storage unit for the nanorobot
- **SWIMMING TAIL:** helps in propulsion inside the body
- **ELECTRODES:** that function as battery for the nanorobot
- **LASERS:** helps in the destruction of target cell
- **SERVO MOTORS:** An important part of any robot which allows the robot to move. ([2])

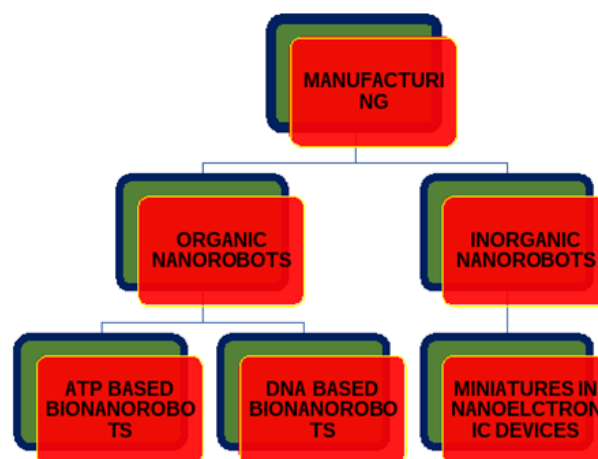
Composition:

The principal element- Carbon

Light elements- hydrogen, Sulphur, oxygen, nitrogen and fluorine ([2])

Manufacture

Manufacturing these nanorobots is done based on 2 types of nanorobots: ([3])



Principle of nanorobots

The nanorobots work under 3 processes:

- Powering
- Communication
- Excretion

Powering- it is done by metabolizing glucose and oxygen and externally supplied acoustic energy. It is usually controlled by onboard computers

Communication- is obtained by acoustic signaling and navigational network installed in the body. It helps to keep track of various devices in the body and communicates with the dentist.

Excretion- after it has completed its work, it is usually retrieved when they effuse themselves via the human excretory channels ([4])

Nanorobotics in periodontal point of view:

1) Oral hygiene and halitosis:

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Nanorobotic dentifrice is mainly kept sub occlusally (dentifrobots). These dentifrices keeps an eye on supragingival and subgingival surface at least once a day and destroys pathogenic bacteria in plaque and food. These bacteria are destroyed by the nanorobots. After the bacteria is trapped, these nanorobots metabolizes the trapped organisms into harmless and odorless vapors and later deactivate themselves if swallowed. ([5])

2) Nanorobotic dentifrice:

Nanoscale particles are added in the conventional dentifrices like mouthwashes and toothpastes and helps in-

- Repelling the deposition of bacterial biofilm
- Prevents early remineralization of carious lesion
- Helps in deposition of minerals which is lost by tooth called enamel remineralization

The nanoparticles that are usually added in the dentifrice are silver nanoparticles and triclosan loaded nanoparticles.

3) Dentinal hypersensitivity

It occurs mainly due to exposing of dentinal tubules caused by either gingival recession or loss of cementum on the root surfaces. Dental nanorobots selectively and precisely occlude specific tubules by reaching towards the pulp. After these nanorobots reach the pulp, the dentist commands nanorobots to close the sensitivity of that particular tooth. This gives a quick and permanent cure for dentinal hypersensitivity. ([6])

4) Oral anesthesia induction:

Oral anesthesia induction can be done in 2 ways:

- Handheld control by the dentist where the dentist inject the nanorobots over the selected tooth. The selected tooth gets anaesthetized. After the procedure, the dentist orders the nanorobots to restore all the sensation
- Analgesic nanorobots can be injected into the patient gingiva which reaches the dentine by migrating into the gingival sulcus and pass painlessly through lamina propria. After it enter the tubules and to the pulp within 100sec the nanorobots have control of all the nerve impulses on the selected area. ([7])

5) Periodontal tissue engineering:

Tissue engineering concepts for periodontal regeneration are usually done by using synthetic scaffolds for cell delivery purpose. In nanorobots, there is usually a self-assembling nano system which undergoes a pre specified assembly with biological system associated with cells and tissues. This leads to periodontal regeneration in the specific area. ([8])

6) Surgical nanorobot:

Surgical nanorobots are guided by the dentist where surgeons use inside the human body. The main functions of these surgical nanorobots are pathology, diagnosis, and correcting the lesion by nanomanipulation coordinated by onboard computers. The main advantage of these surgical nanorobots

is they work at high speed with less side effects. It is usually painless and gives precise diagnosis. ([9])

7) Bone grafting materials:

Bone grafting materials are mainly used for recovering bone that is usually lost during periodontal disease or after extraction. The materials that are used are n-hydroxyapatite, chitosan associated and titanium reinforced materials are commonly used. Nanosized particles such as calcium sulphate, octa-calcium phosphate, nanoceramic composites are used for bone grafting with nanorobots. These materials when used gave good clinical outcomes in terms of bone regeneration and resistance to degradation. ([10])

8) Local drug delivery:

Local drug delivery helps to improve the regenerative capacity of damaged tissues and also helps to treat periodontal disease. These provide therapeutic molecules that could be loaded in carriers such as scaffolds to allow sustained and controlled release. The drug concentration is improved due to sustained release into the periodontal pocket. The materials used as drug delivery 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 ([7]) ([9]) ([13])

9) Quantum dots:

These are usually tiny semi-conductors that are stable, non-toxic and glow brightly when stimulated by UV light. These provide promising nanostructures in diagnostic application, healing of inflamed periodontal tissue and also in treatment of cancer. The quantum dots that are usually used are lead free and cadmium free quantum dots. The mechanism of these quantum dots is:

Nanostructures gets attached to the antibody and attacks the target cell which is stimulated by UV light which gives out reactive oxygen and destroys the particular target cell. ([12])

Study selection should be based on the advantages and disadvantages of these nanorobots which include:

3. Advantages

These nanorobots has a lot of advantages which include:

- Superior hardness, translucency, flexure strength are good
- Faster and accurate diagnosis of oral disease
- Faster elimination of disease
- Less fatigue
- Durability (i.e.) it can remain operational for years, decades or centuries
- HIV, cancer and other harmful diseases are also under progress for curing

- Nanorobots will treat and find disease and restore lost tissues at cellular level in reduced span of time ([12])

4. Challenges

Even though these nanorobots have a lot of advantages there are still some challenges that the clinicians face which include:

- Precise positioning in molecular level
- Numerous ethical issues to deal with social acceptance is a problem
- Toxicity associated with nanoparticles is harmful to humans and environment
- Irretrievable genetic information loss
- Biocompatibility
- Large numbers of microscale nanorobots activities to be controlled
- High design and installation cost
- Hard to interface, design and customize complex
- Maintenance is difficult
- Risk in the field of terrorism- where the human body can be destroyed at molecular level. ([13])

5. Conclusion

Nanotechnology is a predicted future in which dentistry and periodontal practice becomes high-tech and more effective looking to manage individual dental health. Research into nanorobotics is still in its primary stages but can be the best promising future in dentistry.

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