

NANOTECHNOLOGY IN PERIODONTICS- REVIEW ARTICLE

ABSTRACT

The field of nanotechnology is concerned with the study of small objects. This is done through the development of stuff, gadget, as well as organization those display different properties of materials which differ from those found on a larger scale. Use of nanotechnology in the procedures of periodontal treatment has made it possible to allow the treatment with less invasive techniques and reaching the same target. Nanodental care has a lot of promise in terms of developing technologically sophisticated clinical instruments and equipment for oral health care. Robots are said to be capable of inducing oral analgesia, desensitizing teeth, manipulating tissue to realign and straighten crooked teeth, as well as improving tooth durability. The aim of the article is to examine the concept of nanotechnology and how it may be used in dentistry in the form of nanodentistry, a new discipline of dentistry.

KEYWORDS: - Nanotechnology, Nanorobotics, Periodontal therapy, Periodontics

INTRODUCTION-

The word “Nano” means dwarf. Nano is the smallest unit of measurement, which is approx 1/80000 of the human hair diameter. Nanorobots are made of molecules with a unique property that made them possible to carry out a specific task. They are the machines that make everything possible at atomic levels. In the contemporary age, two breakthroughs triggered the evolution of nanotechnology. First, Gerd Binnig and Heinrich Rohrer of the IMB Zurich Research Laboratory invented the scanning tunneling microscope, which is allowed for the unique viewing of individual atoms and bonds, as well as the successful manipulation of individual atoms. The microscope's creators were awarded a Noble Prize in Physics in 1986. Nanotechnology is the undeviated processes of matter at the nanoscale, as defined by the definition. At the nanoscale, this technique allows for practically complete control of matter structure. Drugs usually travel through the entire body before reaching the diseased location. The medicine may be tailored to a specific spot using nanotechnology, making it considerably more effective and reducing the risk of adverse effects. The technology is widely used nowadays in every field, be it medical, engineering, or anywhere else.

HISTORY

James Clerk Maxwell presented the breakthrough notion of nanotechnology in 1867. Richard Zsigmondy conducted the first observations and measurements of nanoparticles in the first decade of the twentieth century, in 1914.^[1] In 1986, the book "The Coming Era of Nanotechnology" predicted that in the not-too-distant future, this technology would be used to combine atoms and molecules to create nanocircuits and nanomachines.^[2] Robert Freitas Jr. was the first scientist to explain nanotechnology and nanorobots in medical applications. He defined nanomedicine as "the science and technology of diagnosing, treating, and preventing disease and traumatic injury; of relieving pain; and of preserving and improving human health through machine systems and nanorobots" in an article published in the Journal of the American Dental Association.^[3]

NANODENTISTRY

People were usually afraid of dental treatments in the past, either because of pain or because of a previous traumatic experience. Nanodentistry has made it possible for people to easily come to the dentist without any anxiety or fear. The science and technology of using nanostructured materials to diagnose, cure, and prevent oral and dental problems, as well as relieve pain and maintain and enhance dental health, is known as nanodentistry.^[4]

Nanodentistry involves three branches- nanorobotics, nanodiagnostics and nanomaterial.

APPLICATION OF NANOROBOTICS –

- 1-Regional anesthetic
- 2-Super sensitivity cure
- 3- Dental biomimetics
- 4- Cosmetics and dental durability
- 5- Ortho treatment
- 6- Dentifrice-robots
- 7- Renaturalizatiuon procedures

8- Nanovector

APPLICATION OF NANODIAGNOSTICS [DIAGNOSIS OF ORAL CANCER AND OTHER DISEASES]-

1-Nanoscale cantilever

2- Nanopore

3- Nanotube

4- Quantum dot

5- Nanoelectromechanical system [NEMS]

6- Oral fluid nano- sensor test

7- Optical nanobiosensors

8- Lab-on-chip method

APPLICATIONS OF NANOMATERIALS-

1- Nanocomposites

2- Nanosolution

3- Esthetic materials

4- Nano-optimised modifiable ceramics

5- Impression materials

6- Nano encapsulation

7- Nanoneedles

8- Self assembly

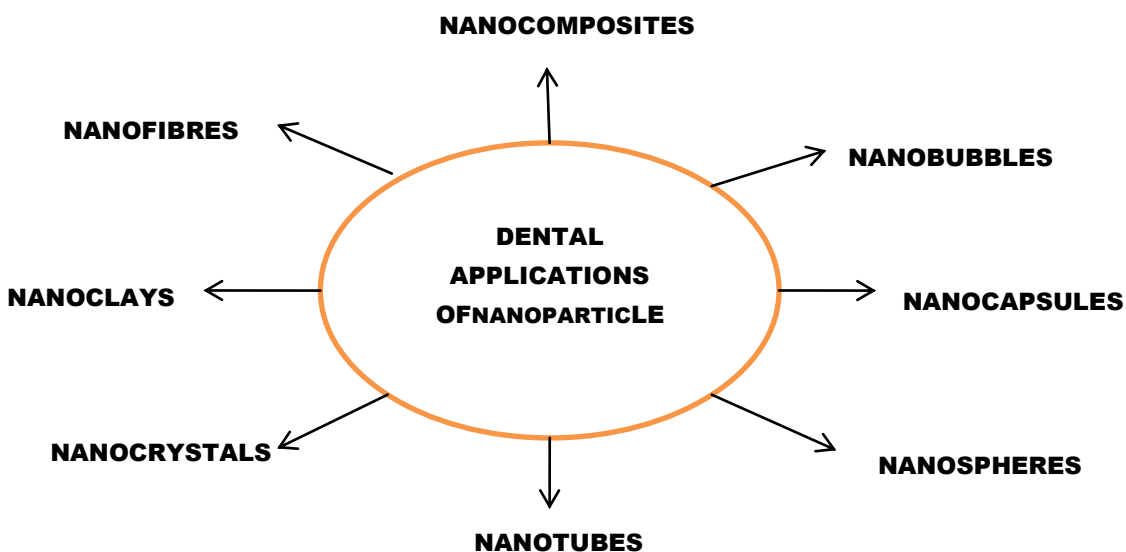
NANOPARTICLES

There are different approaches from which nanoparticles are fabricated. There are three approaches: top-down, bottom-up, and functional ^[5]. Nanoparticles used in dentistry are nanocomposites, nanofibers, nanoclays, nanospheres, metallic nanoparticles etc. Because bacterial colonization is one of the first steps in the progression of periodontal disease, eradicating harmful bacteria using nanoparticles is an effective treatment option. Platinum nanoparticles (PtNPs) can mediate antibacterial effects Streptococci mutants, Enterococcus, and

Porphyromonas gingivalis, according to Itohiya et al ^[6]. To improve the profile utility of AgNP, it was electrodeposited into nanobers.^[7]This biomaterial has also been used to deliver oral medications and to develop an antibacterial oral injury dressing to help prevent gingivitis and gum disease To improve the bio-functionality of electro spun nanofibers, Lee et al. packed AgNPs into .them. The above mention material can be used to generate an antibacterial oral wound dressing and for the administration of oral drugs in order to prevent periodontitis and gingivitis. ^[8] Treatment for the inflamed tissue induced by the persistent type of periodontitis is another way to avoid the illness ^[9] Polydopamine NP_s, Silica NP_s, and Silica NP_s that release nitricoxide ^[10-11]

PROPERTIES OF NANOPARTICLES:-

1. Improved toughness, rigidity, transparency, scratch, abrasion, solvent, and heat resistance, as well as reduced gas permeability.
2. A key feature of self- assembly is that it allows them to self – organize into patterns or structures without the need for outside help.
3. Nanoparticles exhibit biochemical, optic, electromagnetic, and electro-optical characteristics that differentiate them from individual molecules or bulk species. ^[12]



MECHANISM OF NANOROBOTS-

Nanorobots in medication are utilized with the end goal of primarily maintaining and securing the human body against microbes. They range in diameter from 0.5 to 3 μm and are made up of pieces with diameters ranging from 1 to 100 nm. The primary component utilized is carbon as precious stone/fullerene nanocomposite because of its expanded strength and substance dormancy. The exterior passive diamond coating gives a smooth, perfect surface and causes the immune system to respond less. The fueling of nanorobots should be possible by using nearby glucose, oxygen and remotely provided acoustic energy. They can be constrained by installed PCs equipped for performing around at least 1000 calculations each second. Nanorobots can recognize diverse cell types by actually looking at their surface antigens. A nautics network embedded in the body keeps track of all passing nanorobots and gives great positioning accuracy in the human physique. When the cybernetic organisms have completed their mission, they can be regenerated by enabling them to expel themselves through normal human excretion pathways. According to current assumptions, dental nanorobots should have two modes of communication: one with the person that order it, and with the other nanorobot that cooperates with and the two potential methods about imparting connecting nanorobots are being thought of: each through light signals past visual nano detectors or by substance signal through substance nanosensors. With regards to the potential methods of corresponding between nano robots as well as the person who organizes them, Researcher is leaning toward acoustic signals, which allows rapid data transfer, or electromagnetic radio waves, which are useful in determining the present condition of nano robots within the patient.

NANOTECHNOLOGY'S IMPACT ON PERIODONTICS

1- Regional anesthetic –

Most dental strategies include organization of nearby sedation and a few patients concede their dental treatment for the dread of infusions. Really effortless techniques of organization of neighborhood sedation might be feasible by the utilization of nanotechnology. In the era of nano dentistry, the patient's gingiva will be infused with a colloidal solution comprising millions of active analgesic micron size dental robots. ^[13] Nanorobots can reach up to the mash chamber in about 1min and 70seconds, assuming an absolute way length of around 1cm from the teeth surface to the mash and a modest travel speed of 100 min/sec. ^[13] Once

introduced in the mash, these robots may close down all affectability in a specific tooth that requires treatment.^[12]

2- **Cervical super sensitivity** –

Dentin touchiness might be brought about by changes in compulsion communicated hydro dynamically to mash. Reconstructive dental nanorobots using local organic materials might precisely and unambiguously block particular tubules in a matter of minutes, providing patients with a quick and long-lasting cure. On arriving at the dentinal junction, the nanorobots enter gingival rounded openings that are 1 to 4 μm in measurement as well as continue surrounding the mash, directed by the mix of compound angles, thermal difference and even situation of route, all heavily influenced by the locally available nanocomputer as coordinated by the dental specialist. Dental nano robots may carefully and precisely clog particular tubules in minutes using local organic materials, providing patients with a rapid and long-lasting treatment.

3- **Pyorrhoea**-

Kadam et al speculated that secondary utilization of argentums nanoparticle sol with scaling as well as root arranging has predominant impact in contrast with antibiotic medication gel in administration of constant periodontitis.^[14] Nano Pro settling lipid go between as a result of their expanded capacity to enter into periodontitis impacted tissue might be a viable strategy to oversee ongoing periodontitis.^[15] As of late, researchers delivered and described triclosan stacked nanoparticles by the emulsification–dissemination process, while trying to acquire a clever conveyance framework satisfactory for the treatment of periodontal sickness.

4- **Nanomaterials to coax ossein development**-

Nanotechnology means to copy this normal construction for muscular as well as dental applications and, more especially, in order to enhance nanobone. The microstructure of nano gems is free, with nano holes placed in the middle of the gems. The walls of the pores are altered such that they adsorb protein, because of the expansion of silica atoms. Bone imperfections can be corrected by utilizing hydroxyapatite nanoparticles.

5- **Sub gingival irrigation**-

Hayakumo et al. have shown how ozone Nano bubble water made by Nano bubble invention may be used in the sub gingival water system. Because of their increased antibacterial

movement, According to their results, it might be utilized as a complement to periodontal treatment^[16]

6- **Nanorobotic dentifrices** –

Nonstop evacuation supra and sub gingival plaque and math through designated Nano robots sub occlusal-abiding nanorobotics dentifrice conveyed by mouth rinse or pepsodent could watch all supra-gingival and gingival surfaces one time each day, processing caught natural matter into innocuous as well as scentless fumes and executing nonstop math surgical processes. These undetectably little dentifrobots [1-100 micron], slithering at 1-20 mic/sec, would be economical, simply electronic gadgets, that would securely deactivate themselves if gulped and would be customized for better cleaning of the teeth^[17] Appropriately designed dentifrice robots could distinguish and annihilate pathogenic microbes living in the plaque and somewhere else, while permitting the B500 types of innocuous oral micro flora to prosper in a solid biological system. Dentifrice robots would likewise give a ceaseless boundary to offensive breath, since microbes festering is the focal systemic interaction included in foul smelling breath.

6- **Gingival surgeries**-

Momentous properties of TiO₂-based nanoparticles combined with laser illumination used in assortments of strategies like depigmentation of gingiva, delicate tissue entry point without sedation and periodontal sickness therapy.

7- **Nanotechnology used in Periodontal Drug Delivery** –

Nanomaterials that are generally utilized for adequate medication discharge are center shell circles, empty circles, nanotubes and nanocomposite.^[17] Nanotechnology has substantiated itself as a possible wilderness in medicine conveyance to explicit cells or limited space of interest utilizing nanoparticles. Additionally, a close utilization of nanostructure doxycycline gel was employed to preserve bone misfortune in an exploratory periodontal infection model.^[18] Medications are joined into nanospheres made out of a non- toxic polymer, and this takes into account planned delivery of the medication as the nanospheres corrupt working with site-explicit medication conveyance.^[19]

8- **Biofilm the board**-

Bio-inspired Nano estimated apatite's have been blended for balance of bio-grip and biofilm the board in the structure of dentifrices, mouth washing arrangements, and demineralizing glues (liquids) for use in preventive dentistry.^[20]

9- Nanotechnology in Covid illness (COVID)-19 –

Nanotechnology joined in Personal protective equipment, mouth covers have antibacterial movement and have shown expanded security clinical equipment as well as numerous other exceptionally infectious surfaces.^[21] Nanotechnology in analytic packs makes it compact with higher adequacy, affectability, and explicitness compact. The utilization of nanoplasmonic detectors in the analytic packs help in quick identification of even live infections utilizing its particular immunizer.^[22] This has been essential in the Covid-19 pandemic, where nanoparticles are being used to restrict the spread of Corona virus^[23]

CHALLENGES LOOKED BY NANODENTISTRY-

[A]- Designing difficulties:-

1. Practicality of large scale manufacturing method.
2. Exact positioning and assembly of sub-atomic scale components.
3. Controlling and planning exercises of enormous quantities of autonomous miniature size robots all the while.

[B]- Natural difficulties:-

- 1- Creating bio amicable nanomaterial.
- 2-Guaranteeing similarity with all mind boggling of human body.

[C]- Social difficulties:-

- 1- Morals.
- 2-Public acknowledgment.
- 3-Guideline and human wellbeing.

THE ROLE OF A DENTIST IN NANODENTISTRY:-

The question that arises in the mind is, if everything is done by computers, what will be the role of a dental professional at that point? In any case, fortunately the job of a dental specialist will develop with time what's more, it would be really demanding. Instances of basic disregard will become less and patients of uncommon illness and stylish concern will turn out to be more. Treatment choice will be more demanding and we will actually want to make the analysis with patient inclination and his hereditary make-up as a main priority. The greatest specialized powers, proficient judgment, and solid expert patient relational skills, which are the hallmark of the current dentistry specialist, will be of much greater interest than they are now.

FUTURE OF NANOTECHNOLOGY:-

Anticipating what's to come is a dangerous business. Regardless, it's not too early to think about, examine, and try to influence the prospective implications of nanodentistry. Nanodentistry will result in very effective and highly viable tailored dental medications. For regenerating tissues, a new age of cell-based therapies will be available, as well as pain-relieving drugs and prescriptions that are custom-tailored to improve health and well-being. In any case Nanotechnology, like all advances, has a notable potential for embezzle and mistreatment on a size and scope never seen before. Nanodevices are invisible but have tremendous capabilities.

DRAWBACKS AND LIMITATIONS :-

Insignificantly intrusive methodology require uncommon hardware which could be more costly, trained professional preparing, and additional time as certain techniques may take longer than expected, contrasted and traditional medical procedures.^[24] In spite of the fact that there is sufficient science to help the turn of events and clinical utilization of insignificantly intrusive periodontal .Best case scenario, even in the possession of profoundly gifted clients, these procedures are lumbering and have a precarious expectation to learn and adapt.

CONCLUSION-

From here we can conclude that Nanotechnology is future of dentistry. It will give patients painless and best result of the treatment. In the periodontics it can prove the best way as it is the minimally invasive method for treatment.^[25] The future offers even more progress toward a more primary preventative strategy, aided by new technologies diagnostic, preventative, and treatment technologies treatment. However, there are certain technological and cultural issues to consider.

There are both technical and financial hurdles to overcome in order for this to happen. In clinical practice, this is completely realized. The specialist can easily monitor the patient with the help of this robot.

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