



## PROSPECTS OF NANOROBOTICS IN DENTISTRY

### Prosthodontics

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### ABSTRACT

The purpose of the present article is to provide an exhaustive review of the speculated applications of nanorobots for the diagnosis and treatment in dentistry. The introduction of nanotechnology in dentistry can augment the quality of dental health diagnosis and treatment to an unprecedented higher level. In this respect, the role of nanorobotics is worth mentioning. Nanorobotics is an emerging technology for creating microscopic machines or robots with dimensions nearly one nanometer (10<sup>-9</sup> meters). Nanorobots are intelligent nanoelectromechanical systems having components such as on-board sensors, manipulators, motors, power supplies, and molecular computers. They are capable of intruding into the human body either through the vascular system or through catheters. From the review of the related articles, it was seen that nanorobots can have made revolutionary changes in dental disease diagnosis and treatment. They have high potential to function at the atomic, cellular, and molecular levels and can penetrate human tissue with navigational precision in response to its sensor stimuli, the preprogrammed instructions from onboard nanocomputer, and strategic orders of the dentist through signals. Its role is effectively extended to the field of anesthesia, hypersensitivity, Orthodontic treatment, Aesthetic dental treatment, oral cancer, oral hygiene, halitosis, etc.

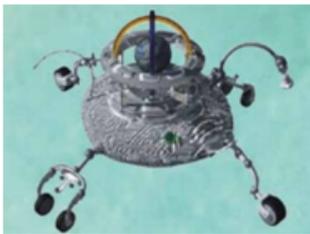
### KEYWORDS

Nanotechnology, Nanodentistry, Nanorobots, Nanorobotics

### INTRODUCTION

Nanotechnology has attracted significant interest in various fields all over the world. Nanorobotics is a new area of scientific advancement promising revolutionary changes in medicine, biology, and industrial manufacturing. Nanorobots are intelligent nanoelectromechanical systems of dimension less than a micrometer, consisting of nanoscale components such as on-board sensors, manipulators, motors, power supplies, and molecular computers with dimensions ranging from 1 and 100nm. Intelligence, actuation, signaling, sensing, information processing, swarm behavior at the nano-scale are the functions intended to perform by the nanorobots [1].

There are ample opportunities for the application of nanorobots in various specialties in dentistry. Even though no functional nanorobots have yet been developed, it is believed that nanorobots will become an important part of future dental and periodontal health. This article provides an exhaustive review of the speculated applications of nanorobots for the diagnosis and treatment in dentistry.



**Figure 1: Model of Dental Nanorobot**

Source: [www.researchgate.net/publication/267633456](http://www.researchgate.net/publication/267633456)

Nanorobots for use in dentistry should have the property to penetrate human tissue with navigational precision in response to its sensor stimuli, the pre-programmed instructions from onboard nanocomputer, and the strategic orders of the dentist through signals. The potential application of nanorobots in dentistry extends to both for diagnosis and treatment. In this section, some important applications of nanorobots in dentistry for diagnosis and treatment are enlisting.

### APPLICATION OF NANOROBOTS FOR DIAGNOSIS

Nanorobots can be used for the early identification of diseases at the cellular and molecular levels. Nanorobots can collect human fluids or tissue samples, with increased efficiency and reliability for in vitro diagnostics and multiple analytics at a subcellular level[2]. They can be effectively used to insert into the human body to detect the presence of diseases and measure the extent of tumor cells, toxic molecules, etc.[3].

Nanorobot fitted with Nano Electro-Mechanical System (NEMS) can be used for the detection of oral cancer. NEMS includes electromechanical nanothermometer, jet nanoengine, nanosyringe, and sensors. Nanosyringe simultaneously functions as a nanoprobe for individual biological molecules and drug nanodelivery. The ultrasensitive NEMS biosensors supported by other gadgets effectively detect the 10-12 bacteria, viruses, and DNA which facilitate the detection of oral cancer [4].

### APPLICATION OF NANOROBOTS FOR TREATMENTS

The design of dental nanorobot is being envisaged by scientists to accomplish numerous task, like preventive, restorative and curative procedures. Nanorobots can be effectively used to apply local anaesthesia, induce oral analgesia, manipulate the tissue to realign and straighten malaligned teeth, desensitize tooth, and to improve durability of teeth.

#### Inducing local anesthesia

For inducing local anesthesia, millions of aesthetic dental nanorobots in the form of colloidal suspension will be applied to the patient's gingiva. These nanorobots reach the pulp via the gingival sulcus, lamina propria, cemento-enamel junction or dentinal tubules. After reaching the pulp, nanorobots interrupt the nerve impulse traffic of tooth that requires treatment, according to the instructions of the dentist through the intermediate use of the on-board nano-computer. The action of aesthetic nanorobots is painless and reversible with no side effects or complications.



**Figure 2: Nanorobots in local anesthetic solution**

Source: [www.researchgate.net/publication/267633456](http://www.researchgate.net/publication/267633456)

When the oral procedure is over, the nanorobots can restore the nerve impulse traffic and exit the tooth through the way they entered in accordance with instruction of dentist[5].

#### Treatment for dentine hypersensitivity

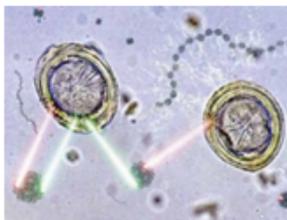
Dentine hypersensitivity is caused by hydrodynamically transmitted pressure to the pulp, through the dentinal tubules of the exposed

dentine. The surface density and diameter of dentinal tubes of hypersensitive teeth are respectively eight times and two times bigger than those on non-sensitive teeth[6].

Reconstructive dental nanorobots can be administered to the tubular holes and they could proceed toward the pulp on the basis of sensor stimuli about the chemical gradients and temperature differentials under the control of the dentist through the onboard nano-computer. These nanorobots will occlude the selected dentinal tubules with high precision and speed to provide quick and permanent treatment of the dentine hypersensitivity [7]

#### Orthodontic treatment

Specially designed orthodontic robots can be used for manipulating periodontal tissues including gingiva, periodontal ligament, cementum and alveolar bone so as to facilitate painless tooth rotating, uprighting, and vertical repositioning at high speed with enhanced accuracy [8][9].



**Figure 3: Orthodontic nanorobots**

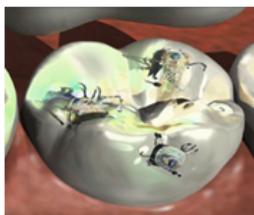
Source: [www.researchgate.net/publication/267633456](http://www.researchgate.net/publication/267633456)

#### Aesthetic dental treatment

Reconstructive dental nanorobots can be employed for aesthetic dental treatment. These nanorobots are capable to replace the upper layers of the natural tooth enamel with artificial biocompatible materials like diamond and sapphire, so as to increase aesthetic aspect of color, texture and hardness. These type of nanorobots can also excavate old amalgam restorations and prepare the cavities for restoring the teeth with biological materials similar to natural teeth [6][10]

#### Treatment for oral hygiene and halitosis

Nanorobotic dentifrices can effectively support the treatment for oral hygiene and halitosis. These type of nanorobots, can identify and destroy pathogenic bacteria residing in the plaque and elsewhere, while allowing the harmless bacterial flora in the mouth to develop in a healthy ecosystem.



**Figure 4: Three robots examine and clean the occlusal surface of a patient's tooth. As an aide to visualization, the artist has depicted the dental nanorobots about 1000 times larger than actual size.**

Source: [www.researchgate.net/publication/267633456](http://www.researchgate.net/publication/267633456)

When these nanorobots are administered into the mouth in the form of mouthwash or toothpaste, they can metabolize organic matter trapped on the subgingival surfaces, into harmless and odorless vapors. These nanorobot can provide a continuous barrier to halitosis and can play an important part in preventing caries and periodontal diseases. Being a mechanical device, it is capable to deactivate itself when swallowed [6][11].

#### Treatment for oral cancer

The nanomedicaldestrorobots are capable to fight against cancer in the oral cavity. They have the ability to investigate and destroy presence of cancerous cells in the oral cavity in utmost accuracy. The destrorobots penetrate the tumor and use lasers, microwaves or ultrasonic signals for attacking neoplasm cells in blood vessels without breaking the cell wall by increasing the pressure or intracellular temperature[12].

## DISCUSSION

As explored, nano-robot designs can be catered for numerous purposes like preventive, restorative and curative dental procedures. Though nanorobotics has been a actively researched field during the last two decades, there are several pressing concerns on both the safety of their application and the toxicity of materials used[6].

The potential toxicity of materials and long-term effects on the human application relatively unexplored. Additionally, the effect of the materials with respect to environmental factors like pH, temperature and chemical exposure need to be understood for approved clinical use [13].

Furthermore, there are concerns related to design/engineering and industrial scale production of these systems. There are also operational concerns like molecular level assembly, dexterity, accuracy and control[14].

## CONCLUSIONS

In this article, an attempt was made for an exhaustive review of the important speculated applications of nanorobots for the diagnosis and treatment in dentistry. Nanorobots are tiny intelligent nanoelectromechanical systems with on-board sensors, manipulators, motors, power supplies, and molecular computers. Intelligence, actuation, signaling, sensing, information processing, swarm behavior are the intended functions of the nanorobots. The reviewed literature revealed that there are ample opportunities for the application of nanorobots in the various specialities of dentistry. Nanorobot can be used for the early identification of diseases at the cellular and molecular levels. It can collect human fluids or tissue samples for diagnostics and multiple analyses at the subcellular level. The design of dental nanorobot is to accomplish numerous tasks including preventive, restorative, curative procedures. Nanorobots can be effectively used to apply local anesthesia, induce oral analgesia, manipulate the tissue to realign and straighten irregular set of teeth, desensitize teeth, and improve the durability of teeth.

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