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An Analytical Recap of Nanotechnology for Dental Applications

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ABSTRACT: ***Biological nanotechnology applications have advanced significantly during the past few generations. Nanomaterials have a proven track record in several dental applications, strengthening of polymeric composites, endodontic uses, involving tissue repair, and implantation coatings. The development of new nano-biomaterials and the modification of the characteristics of currently existing biomaterials have raised the bar for oral health care standards. To envision the future of dentistry, one must have a better understanding of nanotechnology. These intriguing materials are anticipated to find several dental applications with better therapeutic uses during the next ten years. This stud's goal is to go through the existing uses of nano-biomaterials in dentistry, as well as recent advancements and possible prospects.***

KEYWORDS: ***Dentistry, Nanotechnology, Nanomaterials, Nanorobot.***

1. INTRODUCTION

Nanotechnology is the study, design, and production of materials and technologies on the nanoscale scale. Nanomaterials are materials having components smaller than 100 nm in at least one dimension. For the past two decades, nanotechnology has found its way into industrial applications such as aesthetics, packaged food, and cleaning products. Nanotechnology and nanoparticles are employed in healthcare for diagnosis, prevention, and treatment. The application of nanotechnology has several uses, including surgery, tissue healing, drug delivery, and tissue replacement. Nanoscience has recently acquired a lot of momentum in dentistry since it works with nanostructures for diagnosing and treating tooth disorders. The goal is to achieve optimal oral health by employing nanomaterials, bioengineering, and nanorobotics to regenerate mouth tissues [1], [2].

1.1. Nanomedicine:

Robert A. Frietas, Jr. coined the term "nanomedicine" in 1993 and described it as "the maintenance and development of human health utilizing molecular instruments and molecular understanding of the human body". It performs a variety of tasks, from delivering drugs to their intended targets to building tissue scaffolds using nanoscale molecules [3].

1.2. Nanorobots:

Nanorobots have a diameter of between 0.5 and 3 m and are constructed from parts of nanoscale dimensions. The main constituent is carbon, primarily in the form of diamonds or fullerenes. These nanorobots respond to predetermined instructions once they are within the target tissues. This provides the freedom to manage and carry out operations at the cellular and molecular level. Nanorobots have been used in several medical applications, including gene therapy, diagnostics, and pharmaceutics [4]–[6].

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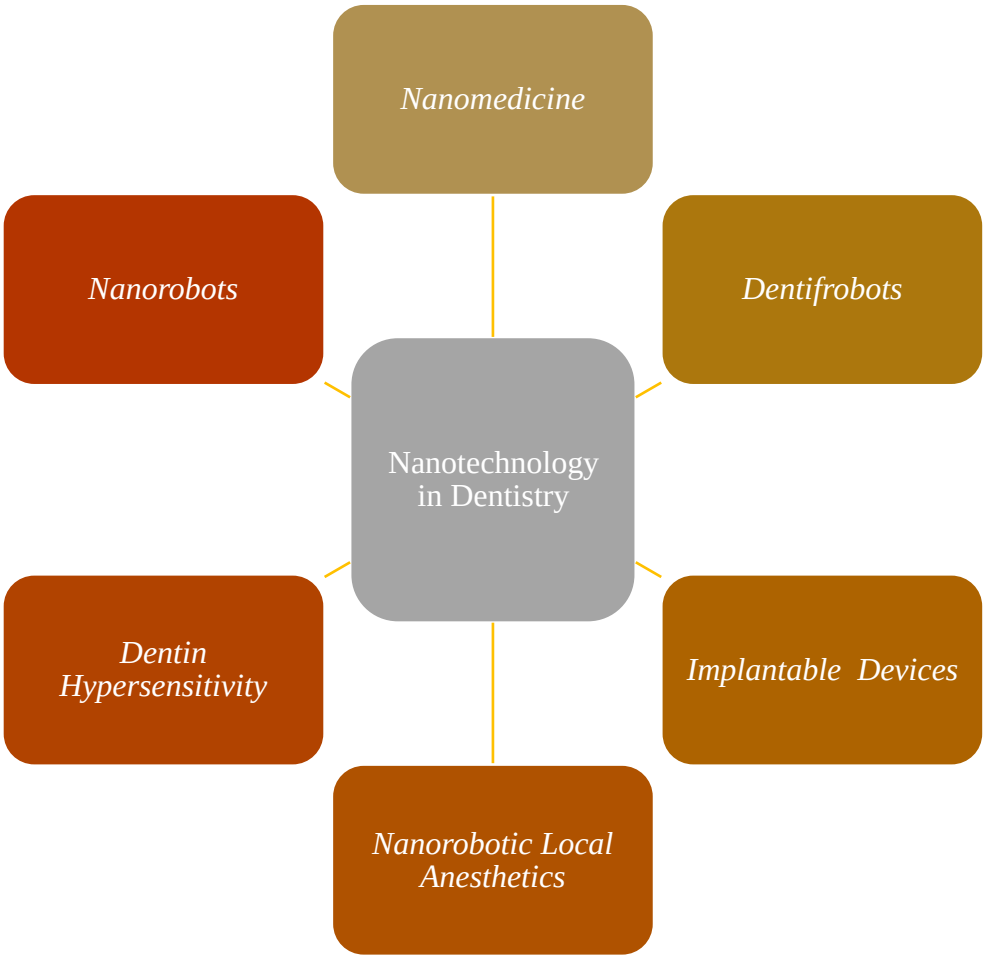

Figure 1: Illustrating the various Applications of Nanotechnology in Dentistry.

1.3. Implantable Devices:

Nano-implanted devices are used in a variety of sectors, including osseous healing, implant coating materials, cochlear materials, tissue replacement materials, smart materials, bioresorbable materials, and diagnosis and therapy aids [7].

1.4. Dentin Hypersensitivity:

Dentinal tubules can be accurately and preferentially blocked by reconstructive dentistry nanorobots, providing a speedy and effective treatment. Through the dentinal tubules, those nanorobots move in the direction of the tooth pulp. Clinical studies have shown that desensitizing toothpaste with 15% hydroxy-apatite nanomaterials is successful in reducing dentin hypersensitivity even after only one application over four weeks [8]–[11].

1.5. Nanorobotic Local Anesthetics:

A colloidal mixture of active nanosized local anesthetic molecules makes up nanorobotic local anesthetics. The anesthetic, when administered to the gingival or mucous membrane and indicated, passes through the epithelium and connective tissues of the gingiva to enter the pulp, giving the clinician controlled, selective anesthesia. By using biochemical and temperature gradients, these ambulatory nano active solutions are guided to the target region. The dentist may instruct these nanorobots to turn off all neuro-sensory feelings to a specific tooth or a group of teeth after they have reached the pulp and taken control of the nerve-impulse traffic.

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The nanorobots may be signaled once more to restore feeling when the treatment is finished, and they are then aspirated.

1.6. Dentifrobots:

Dentifrobots are nanorobots that are included in dentifrices and mouthwashes that work to continually prevent the buildup of calculus while removing organic residues by moving through the gingival tissues at a speed of around 10 microns/second. They may also become inactive if the patient inadvertently swallows them. With the use of dental robots, halitosis may be avoided by specifically identifying and eliminating dangerous bacterial species in plaque biofilms.

2. DISCUSSION

Future applications will focus on the possible effects of scientific and nanotechnological advancements. Dental science advancements are on the horizon, but they need further study to fully understand them. The current state of nano dentistry can be improved by nanomaterials and nanodevices. The dentist will be able to perform curative and reconstructive treatments in the mouth cavity at the cellular and molecular levels thanks to nano-robots made with nanometer precision. Future nanodentists would make effective use of the body's inherent healing, immunological, and homeostasis capabilities, and dental care will be tailored to each person's genetic profile. Nano-hydroxyapatite may one day be used to restore bone that has retreated over time after tooth extraction, eliminating the need for implants.

Dental restoration procedures have been improved as a result of the transition from mechanical to adhesive preservation and the introduction of novel filler nanoparticles. With the emergence of nanobiomaterials as a practical tool, nanotechnology has been used to the field of prosthodontics, among other dental applications. The investigation utilized nanotechnology for additional dental applications have grown exponentially to date. Due to its mechanical and aesthetic qualities, silica-based nanoparticles are especially well suited for dental applications. Silica is a perfect material for many dental applications due to its versatility in surface modification, size control, and biocompatibility.

The idea that current developments in nanotechnology, functioning as biomimetic tools, offer great potential to overcome the hurdles and promise for enhanced dental tissue regeneration is backed by a lot of data, despite the obstacles that still need to be addressed. Nanomaterials designed for engineering dental tissues are constantly being developed, and they have several positive therapeutic effects on dentistry. These include better methods for treating periodontal problems, improved mandibular and maxillary bone regeneration, maybe more biological ways to restore teeth after carious injury, and perhaps even the ability to regenerate teeth that have been lost. Dental treatments that are efficient and incredibly effective will be made possible by nanotechnology. Regenerative dentistry will soon be widely used in ordinary dental practise in order to generate effective treatments and significantly raise patients' quality of life, thanks to advancements in bioengineering research.

For dental applications, a number of nanomaterials have been suggested that clearly outperform their traditional formulations. Although they have proven potential uses, more study is needed to confirm their true therapeutic impact. The use of nanoparticles in dentistry can now only be generalised, and no strategy has yet been developed for a wide range of other uses. Given tissue characteristics and probable internalisation, the toxicological component of nanoparticle safety is a contentious topic in dentistry. It is obvious that these elements need to be carefully considered. However, the importance of nanotechnology research in the dentistry industry is

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growing, and a number of these difficulties will be overcome quickly, solidifying the introduction of these goods to the market.

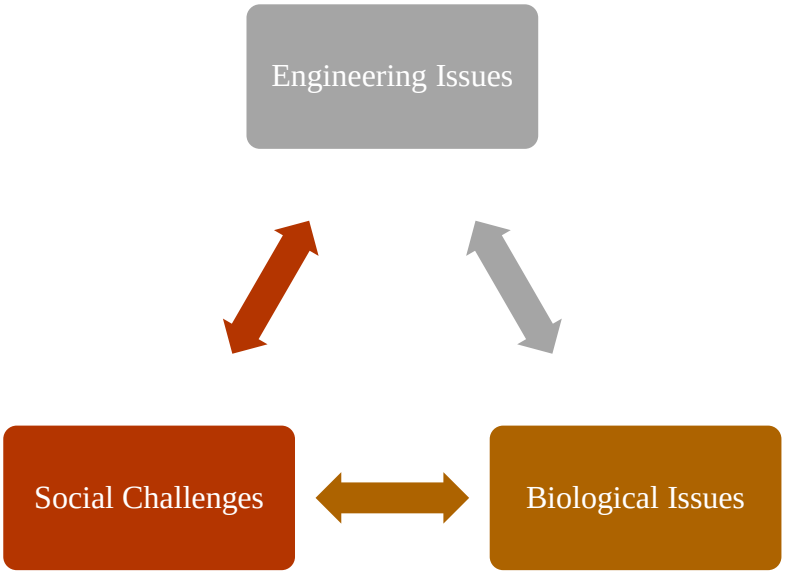

Figure 2: Illustrating the three major challenges in using Nanotechnology for dentistry.

3. CONCLUSION

The administration of healthcare will be shaped in the future by developments in nanotechnology. Despite being invisible to the human eye, nanodevices are capable of great things. Significant advantages, such greater health, better use of natural resources, and decreased environmental damage, might result from them. These nanodevices, however, also carry a considerable risk of abuse and exploitation. Nanodentistry stresses the main treatment of oral diseases in order to provide patients with complete oral healthcare. A variety of oral disorders can be avoided or treated at the first symptoms of occurrence thanks to the availability of sophisticated and precise diagnostic techniques. In spite of the fact that nanotechnology might currently seem like science fiction, the horizon offers great potential for exploiting and optimising this technology for the betterment of humanity. Dentistry, medicine, and human existence will all be significantly altered by nanotechnology.

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