# NANO TECHNOLOGY: AN UPDATE IN MAXILLOFACIAL SURGERY- A REVIEW

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**Abstract:**
Nanotechnology has been defined as "the creation of functional materials, devices and systems through control of matter on the nanometer scale (1-100 nm), and exploitation of novel phenomena and properties (physical, chemical, and biological) at that length scale. The generally recognized nanotechnology categories include diagnostics, imaging, medical devices, drug discovery, drug delivery, and regenerative medicine. 'Nanotechnology' influences almost every facet of everyday life, from security to medicine. Nanomedicine can offer impressive resolutions for various life-threatening diseases. This article discusses the inception of nanotechnology, its advantages, disadvantages, and its application in the field of oral & maxillofacial surgery.

**Keywords:** Nanotechnology, Nano-medicine, Oral& Maxillofacial Surgery.

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## INTRODUCTION:

Richard Feynman (1959) introduced the concept of nanotechnology. Nanotechnology is defined as it is technology as well as research development at the atomic, molecular, or macromolecular levels; on the scale of approximately 1 to 100-nanometer scale; to provide a fundamental understanding of phenomena and materials at the nanoscale; and to create and use structures, systems, and devices which have novel properties and functions because of their small and/or intermediate size.[1]

Although nanotechnology is a relatively new field, there are many applications in use or under investigation. Different specialties have benefitted from nanoscale refinements of diagnostic and therapeutic techniques. Oral & Maxillofacial Surgery is a diverse specialty encompassing trauma, oncologic and congenital reconstruction; Implantology, and aesthetic surgery. Currently, Maxillofacial Surgeons are researching the utility of nanoscale devices for drug delivery, bone regeneration, soft tissue repair, cancer treatment, nerve repair.

This article discusses the inception of nanotechnology, its advantages, disadvantages, and its application in oral and maxillofacial surgery.

## DISCUSSION:

Due to the high surface area to volume ratio, nanoparticles provide mechanical, optical, chemical, and magnetic properties superior to the original materials.

**Types of nanoparticles-**

Nanoparticles are divided into three categories-

**1) Fullerenes-**These are the carbon allotropes that can adopt different shapes, such as carbon nanotubes. The cylindrical shape of a nanotube is derived from the hexagonal lattice of carbon atoms, forming a sheet that can be rolled up. This molecular arrangement provides considerable stiffness and tensile strength (50 times stronger than steel). When combined with an anti-thrombogenic surface, carbon

nanotubes are suitable for applications such as vascular microcatheters and implants.[2]

**2) Quantum Dots (QD's)-** Semiconductor quantum dots (QDs) are emerging as a new class of fluorescent labels in the era of maxillofacial surgery for imaging and the treatment of tumors. In comparison with organic dyes and fluorescent proteins, these tiny light-emitting particles have unique optical and electronic properties, with superior signal brightness, resistance to photobleaching, and broad absorption spectra for simultaneous excitation of multiple fluorescence colors. QDs also provide a versatile nanoscale scaffold for designing multifunctional nanoparticles with both imaging and therapeutic functions.[3]

**3) Nanocomposites-** The nanocomposites are multiphase solid materials where one of the phases has one, two, or three dimensions of up to 100 nm diameter. In tissue engineering, scaffolds are made up of nanoparticulate fillers, distributed between layers to increase surface area for the interaction of components. Different Fillers are silicones, nanoclays, carbon nanotubes, and polyhedral oligomeric silsesquioxane (POSS), synthetic nanocomposite. Polyhedral oligomeric silsesquioxane has superior physical properties such as oxidative resistance to the composite and mechanical strength. These properties of POSS increase the ability of the nanocomposite to support cell adherence and growth, making it ideal for tissue engineering.[2,4]

**Programming of nanotechnology**

Nanotechnology can bring tremendous changes to the fields of maxillofacial surgery with the aid of nanorobotics, nanomaterials, and biotechnology. The diameter of Nanorobots ranging from 0.5–3 µm, and these are made of components size ranging from 1 nm up to 100 nm in diameter. They can be programmed by clinicians, thus enabling clinicians to execute accurate procedures at the cellular and molecular levels.[5]

**Different Applications of nanotechnology in Oral and Maxillofacial Surgery:**

**1. Drug delivery-**Nanoparticles have a very small size; because of that, they can penetrate some barriers that cannot normally be crossed by larger microparticles and thereby reduce systemic toxicity.[6] Deep tissue infection with multiple drug-resistant organisms coupled with the morbidity of serial operations and potentially toxic systemic therapies can be overcome by a nano-drug delivery system.

**2. Nerve tubulization-**

Nerve regeneration is an area of special interest to both maxillofacial surgeons and nanotechnology researchers. Traumatic nerve injuries results in loss of nerve tissue more than 5 mm frequently require nerve grafting, often from an autologous source.

Nanoscale manufacturing techniques have been employed to avoid the morbidity of autologous nerve grafting and to develop new techniques for the repair of the peripheral nerve. To guide the regenerating nerves tubular and porous nanostructured conduits, using various natural materials, have been developed. To aid in regeneration, these structures have been loaded with various biomaterials or cell types such as embryonic stem cells, Schwann cells, neural stem cells.[5]

Wang et al. studied Chitosan nanofiber mesh tubes in sciatic nerve injuries in a rat model, in which they found the partial recovery of sensory function as the nerves elongated through the tubes.[7]

**3. Soft tissue repair and healing-**

Wound healing can be improved by wound dressings constructed using nanoscale fabrication techniques. In rat models, scaffolds made up of collagen nanofibers accelerate acute wound healing by enhancing capillary and fibroblast proliferation.

In a study by Choi et al., immobilized recombinant human epidermal growth factor (EGF) on electron biodegradable nanofibers to cure the diabetic ulcers in a rat model.[8]

Chitin and chitosan nanofibrils are the nanocrystals obtained from the skeletons of the crustaceans. These fibrils have been used in different formulations to assist wound healing. Muzzarelli et al. showed in murine models that different formulations of chitin nanofibrils almost lead to normal physiologic repair of wounds.[9]

**4. Bone regeneration-**

For bone regeneration, the induction of progenitor cells into osteoblasts is an important component. The novel application of nanotechnology uses specific

nanoscale surfaces to produce specific cellular responses, such as osteoblastic differentiation.

Oh et al. studied the effect of culturing human mesenchymal stem cells (hMSC) on Titanium Oxide nanotubes ranging from 30 nm to 100 nm in diameter. They found that the larger nanotubes cause the elongation of human mesenchymal stem cells and consequently encouraged differentiation into osteoblastic cell lines. This technique could improve the previous methods of osteoinduction that involve gene therapy.[10]

**5. Cancer treatment-**

Quantum dots and Colloidal gold Nanometer-sized particles have size-tunable properties that neither discrete molecules nor bulk materials can provide.[3] These particles have properties like the potential for tumor localization, mapping of sentinel lymph nodes, detection of tumor margin, identification of important adjacent structures, and detection of residual tumor cells or micrometastases.

**6. Local nanoanaesthesia-**

Local Nanoanaesthesia is a colloidal suspension containing millions of anesthetic dental nanorobots that would be used for induction of local anesthesia. After deposition on the gingival tissue, the nanorobots would move to the dentin and then reach the pulp through the dentinal tubules; a path towards the pulp would be guided by temperature gradients, chemical differentials, and positional steering by a nanocomputer under the control of the clinician. After reaching the pulp, the analgesic robots may close down all sensations in the tooth. After the treatment procedure has been concluded, the nanorobots may be ordered to reestablish all sensations and exit from the tooth. This technique is advantageous as it reduces apprehension and is fast and reversible.[11, 12]

**7. Nanoneedles-**

Nanostructured stainless steel crystals have been used to manufacture suture needles. nanotweezers are also underway that may enable cell surgery feasibly.[13,14]

**8. Nano sterilizing solution:**

Gandly Enterprises Inc Florida has developed a new sterilizing solution following the nanoemulsion concept. The concept is the nanosized oil droplets attack and destroys pathogens.[15], E.g., Eco Tru Disinfectant

## CONCLUSION:

Nanotechnology has an enormous range of applications in oral and maxillofacial surgery. Specifically, wound management, imaging, implant, tissue engineering, and drug delivery systems have each been influenced by advances in nanotechnology. The use of nanotechnology will increase exponentially as the understanding of biology on the nanolevel progresses. These features make nanotechnology an influential tool when applied to all aspects of oral and maxillofacial surgery.

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