

Nanoparticles in Prosthodontics

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ABSTRACT

In an evolutionary era, technology is continuously undergoing a countless evolution. Emergence of nano science has led to the interest in the arena of molecular science, which has great medicinal as well as dental applications. Term nanotechnology is highly predicted by the researchers based on high technology and effective management at the microscopic level. In future it will gain its importance in dental and periodontal health. The definition of nano science has been extended to include features as large as 100 nm since its origin, but the nanotechnology mainly consists of processing, separating, consolidating, and deforming of materials by one atom or molecule. This review article mainly deals with the application of nanoparticles in prosthodontics.

Key words: Nanoparticles, Nanotechnology, Prosthodontics, Nanomaterial

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INTRODUCTION

The inquisitive mind of human has always led to innovation in the field of science. Today science has a profound effect on the way we live, largely through technology and the use of scientific knowledge for practical purposes [1].

The first use of the concept 'Nano-technology' was by a Physicist Richard Feynman on 29th December, 1959. In this field developing new materials and machines with nano-scale dimensions and ranging from novel extensions of traditional physics to completely new approaches based upon molecular build. The pharmaceutical research in nanotechnology has been a most important invention while considering its application in dental materials [2]. Nanotechnology is extremely diverse and multidisciplinary field. The growing interest in the field of Nano sciences leads to emergence in the field of dentistry also called as "Nano dentistry". Due to the emergence of nano dentistry there is also an improvement in the oral health and hygiene by the use of nanomaterial, biotechnology and dental nano robotics [3]. Nanoparticles have shown to be much more efficient when it is linked with bulk material. The unique size provides with much more superior properties and several biological belongings.

Prosthodontics is a branch of dentistry which mainly deals with restoration by the means of artificial substitutes *i.e.* prosthesis. Prosthesis may be either in the form of fixed removable, maxillofacial or implants. As prosthesis comes always in contact with oral tissue and saliva, its properties and biological factors are always at a great risk in dentistry. In this recent era many studies in the literature, proved antifungal and antimicrobial property of nanoparticles to be an efficient barrier. Various dental materials are available through nano crystallization to improve their original performance and play continuously key role in oral applications. The field of nanotechnology epitomizes a general gestalt of the uses of several nanoparticles in prosthodontics. In particular, suitable applications in acrylic resin, tissue conditioner, dental composites, denture teeth, dental porcelain, implants and maxillofacial prosthesis are appraised.

So, this article mainly focuses on the various applications of nanotechnology in the field of dentistry, especially prosthodontics.

LITERATURE REVIEW

History

- Dr. Richard Phillips Feynman (Discovery of Nano technology).
- In 1974 "Nano technology" was the first word used by Taniguchi
- Eric Drexler in his book "Engines of Creation" popularized and introduced the term "nanotechnology" in year 1986.

- Filtek Supreme in 2002, introduced first as Nano composites in dentistry [4].

Need for nano materials in dentistry

Till date there is no material to be called perfect for dental application, considering the understanding of various materials and the chemical properties with recent improvements in the physical properties. For example, the composite materials have good aesthetic property but are still very technique sensitive and lack mechanical properties. There is no single synthetic material that can respond to external stimuli and act like nature made tissue. Nanomaterials are surrounded with high spirits in terms to either develop or improve the properties of new material or notable improvement in the present materials [5].

Ultra structural classification of nanoparticles

Nanoparticles are broadly classified into three types (Figure 1) [6].

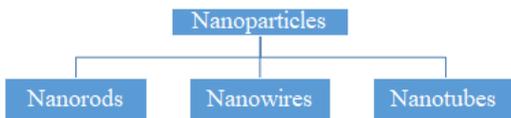


Figure 1: Ultra structural classification of nanoparticles.

Listed below are some options for the production of smart materials for dental applications.

Material synthesis: Properties that are similar to the natural dental tissues and have matching morphological properties there should be production of some synthetic materials.

Biomimetic approaches: By following the nature do principles and producing biomaterials resemble the properties it can help in replacing the lost dental tissues.

Tissue engineering: For replacing the lost dental tissues by regenerations there can be use of regenerative and tissue engineering.

Nanotechnology: Nanotechnology has a dynamic role in all fields of medicine and dentistry. Nano materials, nano robots and biotechnology are considered as the new emerging nano-sized equipment in dentistry. The nano materials include the restorative material, impression materials, bonding agents, implants, maxillofacial materials, ceramics and fluoride releasing agents.

Approaches in nanotechnology

A huge range of nano scale structures have been producing in the current researches. There are two approaches that can be used in fabrication techniques:

Top down approach: In this fabrication reduces large pieces of materials all the way down to the nano scale.

Bottom up approach: Nano-manufacturing the products by constructing them up from molecular and atomic scale components is a time consuming process (Figure 2) [4,5].

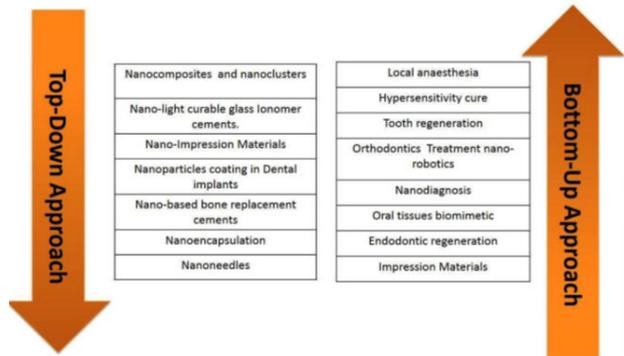


Figure 2: Approaches in nanotechnology

Role of nanoparticles in prosthodontics

Acrylic resin: A complete or partial denture is a removable dental prosthesis which acts as artificial substitute for replacing missing or lost natural teeth and tissues. Plaque accumulation in prosthesis is the main problems faced by patients using these removable acrylic it can be due to surface roughness, porousness and retention of food, which can therefore led to an increase in bacterial activity of cariogenic oral flora. Poly methyl meth acrylate with pigment as titanium oxide and Fe₂O₃ nanoparticles are being manufactured, which also provides the similar hue, as that of gingiva for enhancing the esthetic. This material can be presented as low porosity, higher molecular weight, and an ability to prevent adherence of fungal and microbial growth. Use of nanotechnology will help to develop a polymethylmethacrylate which will be more biocompatible with better mechanical properties [7].

Impression materials: An impression is a negative likeness of tooth or associated structures. Various materials are used to take impression in prosthodontics such as rigid materials, reversible hydrocolloid, irreversible hydrocolloid materials and elastomeric impression materials. Nano fillers are the fillers that can be incorporated in polyvinylsiloxanes, to improve hydrophilic properties of the material, which contain less voids at margin and also the material that has better model pouring which enhances its flow and have detailed precision [6].

Tissue conditioner: Tissue conditioners are most commonly used to provide adequate retention in the resorbed residual cases. To avoid damage to the denture bearing area from injury and trauma usually caused by ill-fitting of the dentures. Maintenance of the prosthesis lined by tissue conditioners can be cleaned by chemical and mechanical methods, but disadvantage of these chemical and mechanical agents can cause considerable damage to the prosthesis relined with tissue conditioners. Various literatures have stated from the studies that silver nanoparticles are well known for its

antimicrobial properties. So to overcome this problem silver nanoparticles are added in tissue conditioners [8].

Denture teeth: Denture in prosthodontics is used to restore a natural missing tooth structure. Denture teeth are made up of acrylic and porcelain. Porcelain is a wear resistant material but has its own disadvantages as it cause residual ridge resorption. So acrylic teeth are more preferable for fabricating a denture, but it undergoes excessive wear. Denture tooth with Nano science comprises of Poly-Methyl Methacrylate (PMMA), and uniformly dispersed nano-sized filler particles which have its own advantages such as it is highly polish able and stain resistant material, superior surface hardness and wear resistance, esthetic material [7].

Light cure nano composites

Development of newer light cure nano composites has been lead due to the advancement of nano fillers into the resin matrix. The main advantage of light cure nano composites is its superior properties with improved mechanical strength and wear resistance. In comparison with micro fill composites it has superior polish and gloss resistance [9].

Implants: Osseo integration of implant is widely accepted in clinical dentistry, failure to which can cause failure of implant. Since the last decade many clinicians have been fascinated by nanostructured hydroxyapatite coatings for implant. Nanostructured hydroxyapatite helps in increasing osteoplastic functions such as adhesion, proliferation and mineralization. It also promotes bone formation around the implant. Treatment such as surface roughening by sand blasting, hydroxyapatite coating have been applied to improve bone growth [10].

Maxillofacial prosthesis: Maxillofacial prosthesis is a prosthesis which artificially restores missing or lost portion of the body. Maxillofacial prosthesis may be intraoral or extra oral, it depends on the defect site. Various materials are used to fabricate maxillofacial prosthesis but most commonly used is maxillofacial medical grade silicone. Prosthesis on defect site can adhere or grow microbial growth on the defect site. Studies have shown that incorporation of silver nanoparticles in maxillofacial prosthesis have prevented the growth of candida albicans without any toxic effect to human dermal fibroblast cells. It also manifests that TiO₂ and ceramic dioxide exhibits least hue changes. Study conducted by Han Y in 2010 states that titanium oxide particles best maintain the ideal properties of maxillofacial silicone when it mixed with medical grade 2186 maxillofacial silicone material [11].

Ceramics: Alumina Ceramics that we use routinely have superior mechanical properties, but its major drawbacks are that it is more likely to crack. Zirconia possesses properties of fracture resistance. Series of studies were conducted with regards to toughness and strength of nano ceramics like, Wang, et al. in his experiment stated that nano ceramic yielded better results when it is compared with other ceramics [6].

DISCUSSION

Challenges faced by nano dentistry

The use of nanotechnology in dentistry has taken the field by storm; there are still various challenges at engineering, biological and social level. Feasibility of mass production, positioning and assembling the molecular scale precisely are some of the challenges at engineering level. Nano materials can be pyrogenic, thus production of a bio friendly material is a biological challenge. Social challenge or social acceptance by the public in the society

Such as ethics and human regulation is still a great matter of concern which needs to be addressed before nanotechnology can enter the modern dental armamentarium.

Safety issues: Nanoparticle is having a smallest diameter which covers the larger surface area. Rate of absorption is mainly depends on the coverage of surface area. Therefore chances of absorption in skin, digestive tract and lungs could be more. This could cause adverse effects in the body. If not taken care then it can be hazardous to human health so proper care should be taken when it comes to nanoparticles, it's because of the safety issues of someone personal health and also for the workers who are mostly involved in manufacturing processes. It can also be harmful for the environment because of the consumers who eliminate it [7].

CONCLUSION

The science and uses of nanotechnology and nano sciences are constantly evolving with the evolving era. This comes with great responsibility to insure the safety, efficiency, and applicability of such new technologies. From developing of new materials or improving the properties of materials there will always be plenty of expectations from nanomaterial's. The advancement in nanotechnologies will act as a future of dentistry. Further research should aim at production of nanoparticle-containing dental materials to enhance the quality of treatments provided to patients. Let us make a change and instead of waiting for something's to happen let's just start believing and contributing our part for a healthier and brighter side of future.

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