International Journal of Enhanced Research in Medicines & Dental Care (IJERMDC),
ISSN: 2349-1590, Vol. 5 Issue 5, May-2018, Impact Factor: 1.338

Nanotech Prosthodontics: A New Frontier

Dr. Samarjit Singh Teja[1], Dr. Monica Malik[2], Dr. Pragati Agarwal[3], Dr. Ginnia[4]

[1]Professor Dept. of Prosthodontics Crown Bridge and Implantology, Swami Devi Dyal Hospital and Dental College Barwala, Panchkula
[2]MDS 2nd year Dept. of Prosthodontics Crown Bridge and Implantology, Swami Devi Dyal Hospital and Dental College Barwala, Panchkula
[3]MDS 3rd year Dept. of Prosthodontics Crown Bridge and Implantology, Swami Devi Dyal Hospital and Dental College Barwala, Panchkula
[4]MDS, Prosthodontics Crown Bridge and Implantology, Swami Devi Dyal Hospital and Dental College Barwala, Panchkula

ABSTRACT

The far reaching potential of nanotechnology is now making it one of the most important and exciting areas of science. Nanotechnology is a novelty for dentistry. The field of nanotechnology and the nanomaterial science has a capability of providing benefits in the field of dentistry. It is believed that with the help of nanotechnology, the oral health of the patient can be improved by providing varying measures of treatment with the help of nanomaterials, nanorobots, and biotechnology. Nanomaterials in dentistry can be metals, ceramics, polymers, tissue conditioner, dental adhesives, implant modifications, maxillofacial prosthesis and composite materials that demonstrate novel properties when compared with conventional materials due to their nanoscale features. The purpose of this article is to review the various nanoparticles used in the manufacturing in the field of dentistry, especially prosthodontics, effects of nanoparticles on patient, dental staff and dental technician and future researches in this field.

Keywords: Nanotechnology, Nanodentistry, Nanoscale, Prosthodontics

INTRODUCTION

The word nanotechnology was derived from a greek word, 'nano' which means dwarf. It is actually prefix which refers to one-billionth of a physical size. Nanotechnology is defined correctly by the scale at which it acts thus one-billionth of a meter which equals to one–ten-thousandth the width of a human hair involving individual atoms or molecules. In other words it is engineering at the atomic or molecular scale. National Nanotechnology Initiative defines nanotechnology as the direct manipulation of materials at the nanoscale. In simple terms, nanotechnology is a technology having a complete control on the matter's structure at the nanoscale level. Nanotechnology is not a new term. The word "nanotechnology" was first used by Taniguchi in 1974. Later, in 1986, Prof Eric Drexler a lecturer, researcher, and writer of nanotechnology quoted the term "nanotechnology" in his book "Engines of Creation." It was introduced into dentistry first as nanocomposites in the year 2002 by Filtek Supreme.[1,2,3]

In nanotechnology particle size reduced to the nanoscale size can suddenly show very extraordinary properties letting them to show unique applications. For example, opaque substances like copper become transparent; catalytic properties are shown by inert materials like platinum; stable materials like aluminium become combustible; solids like gold turn into liquids at room temperature; insulators become conductors (silicon). Materials such as gold, which are chemically inert at normal scales, can serve as a potent chemical catalyst at nanoscales. Thus the potential benefits of nanotechnology making it outstanding above other are by their ability to exploit the atomic or molecular properties of materials and developing newer materials with better properties. Nanoproducts are prepared by building up particles by combining atomic elements and by use of special equipments to create mechanical nanoscale objects[3,4].

Individual Atoms + Molecules = Complex Structure (extraordinary properties)

These nanoparticles because of nanoscale particle size, their structures exhibit significantly new and improved physical, chemical, and biological properties, phenomena, and functionality. Nanophasic and nanostructured materials are attracting moreinterest because of their potential for having specific processes and selectivity, especially in biological and pharmaceutical industry. The applications of nanotechnology are multiple including medicine, environment, energy, information and technology, heavy industry and consumer goods. Use of nanotechnology in the field of dentistry has given birth to a new stream known as 'nanodentistry'. The use of above discussed nanoproducts/ nanoparticles has become very popular in the design and development of many dental materials such that their chemical, physical and mechanical properties can be improved to maximum.[5,6]

Nanomaterials in dentistry can be metals, ceramics, polymers, tissue conditioner, dental adhesives, implant modifications, maxillofacial prosthesis and composite materials that demonstrate novel properties when compared with conventional materials due to their nanoscale features. This review article focuses on the various uses of nanotechnology and their applications in the field of dentistry especially prosthodontics.

APPLICATIONS OF NANOTECHNOLOGY IN PROSTHODONTICS

Nanocomposites: Nanocomposites are made of nano fillers which are arenano agglomerated discrete nanosilica particles treated with 3 methacryloxypropyltrimethoxysilane, (MPTS - coupling agent) to prevent any agglomeration or aggregation and allow chemical bonding of the filler of the resin, matrix during curing. These nano fillers consists of an aluminosilicate powder having a mean particle size of about 80 nm and a 1 : 4 M ratio of alumina to silica,with refractive index of 1.508. It is present in market by the trade name of Filtek Supreme Universal Restorative Pure Nano. Nanocomposites are advantageous over conventional because they have more hardness and wear resistance, show 50 % reduction in polymerization shrinkage and staining, have more translucency, flexural strength, modulus of elasticity and esthetic sense.[1,3,4,5,6,7]

Nano-impression materials: Nanofillers are integrated in the vinylpolysiloxanes, producing a unique addition siloxane impression material having advantsge of better flow, resistance to distortion, heat resistance and high tear strength. When pressure is applied the fluidity of the material is increased due to nanostructure. It is available under the trade name of NanoTech Elite H-D+.[4,5,8]

Nano-cements: Glass Ionomer Cement (GIC) is used as both restorative and luting agent in dentistry. Nano Ionomer is glass ionomer cement whose formulation is based on combination off luoroalumino silicateglass, nanofillers, and nanofiller clusters. These nano Ionomer has high fluoride release, high pulp friendliness, low film thickness of about 15 um and minimum leakage.. Commercially available under trade name of nano ionomer (Ketac N100) Also high antimicrobial properties of dental cements is increased by addition of Silver nanoparticles. Yoshida et al., showed that a dental cement incorporated with silver nano particles had a long term inhibitory effect against S. mutans. [5,6,9.10]

Nano implants: Osseo integration is the basis for dental implant success which is increased by coating of nanoparticles over the dental implants. Nanostructured hydroxyapatite coatings promote bone formation around implant, increases osteoblasts function such as adhesion proliferation and mineralization. One such implant is nano titanium implant which has shorter postsurgery healing time and improved wear and tear.[5,6,7]

Bone graft materials: Ostim (Hydroxyapatite nanoparticles) is used as common bone replacement material in which nanopores are situated between the crystallites. Due to porosity in the nanometer range, most bone replacement material mainly acts on a surface on which proteins can configure. calcium phosphate is another material which increase bone growth. These materials are nano structured, more, osteoinductive, are completely synthetic and non-sintered.[1,5,7]

Nano-Adhesives: Silane treated nanoparticles of silica or zirconia in the size range of 5-7 nm are added to dental adhesives to improve adhesion or cohesion strength. Nanoadhesives has more shelf life, durable marginal seal, higher enamel and dentin bond strength and also release fluoride.[3,6,11]

Dental/Acrylic resins: The importance of acrylic resins is due to their use in making temporary prosthetic base materials, provisional prosthesis, dentures and orthodontic removable appliances such as retainers and functional appliances. Polymethyl methacrylate with Titanium dioxide nanoparticles have been used as additives to biomaterials in order to induce antimicrobial properties and also gives same color as that of gingiva. They are also non cytotoxic to mammalian cell cultures.[3,6,7,8]

Tissue conditioners: Ill-fitting dentures usually results in residual ridge resorption, damage and trauma to denture bearing area: to recover the denture bearing tissue from such insult tissue conditioners are used in dentistry these materials get degenerated with time and are susceptible to colonization by microorganisms**.** Silver nanoparticles are added in tissue conditioners because of their antimicrobial property. Because of their smaller size they also provide large surface area.[6,12]

Denture teeth: Denture teeth should have excellent wear resistant. Porcelain denture teeth have good wear resistance but are brittle in nature. On the other hand acrylic denture teeth lack good wear resistance. But with emergence of nanotechnology, nanocomposite denture teeth composed of polymethyl methacrylate with uniformly dispersed nanosized filler particles are used because they have superior surface hardness and wear resistance, are highly polishable and stain resistant.[7,13]

Maxillofacial prosthesis: Maxillofacial prostheses used to replace facial parts lost due to disease or trauma, to restore the health of the tissues and to improve aesthetics for better social acceptance. Contamination and infection are the potential causes of prosthesis failure. To prevent this silver nanoparticles have been added in maxillofacial prosthesis to prevent the attachment of candida albicans to maxillofacial prosthesis surface without any toxic effect to human dermal fibroblast cells. For color stability of prosthesis nano titanium dioxide, zinc oxide and cerium dioxide as opacifiers are used which exhibited the least color changes [6,14]

APPLICATIONS OF NANOTECHNOLOGY IN OTHER FIRLDS OF DENTISTRY

Nano-Anesthesia: Anesthesia is given by colloidal suspension that comprises of millions of active analgesic micrometer sized dental nanorobot particles induced into the gingival tissue. These nanorobots reach the pulp within 100 seconds and block the sensation of the particular tooth involved.

Nano dentifrice (Dentrifrobots): Dentrifrobots with smaller in size of about 1-10 micron crawling at 1-10 micron/ second are delivered with the toothpaste or and mouthwashes and helps in clearing supra and subgingival calculus and plaque.[1,5,11]

Orthodontic Nanorobots: As compared to conventional molar upright ting techniques which require weeks or months for completion, nano robots by their direct action on periodontium and bone, results in painless tooth straightening, rotating, and vertical repositioning in minutes to hours.[1,5]

Cancer diagnosis: with the advent of nanotechnology diagnosis and treatment of cancer has become less invasive, less uncomfortable means of identifying and quantifying the markers of disease, easy and prompt by monitoring recurrence or metastasis, and defining the locations, biologic types, and behaviors of neoplastic lesions. Nanovectors for gene therapy, Iodinated nanoparticles, nanomaterial for brachytherapy, Biosensors and Nanoelectro mechanical systems (NEMS) has made the treatment easy.[1,5]

FUTURE OF NANODENTISTRY

"Bio-mimicry" is thought to be the future trend in which teeth and bone replacement will be done by natural method means copying the way nature itself lays down minerals. It will be done by biomimetic calcium phosphate coatings and biologically active drugs on titanium dental implants. Though the risk to health and environment from nanoparticles and nanomaterials and the risks posed by molecular manufacturing and social risks need further investigation.[4,5,15]

CONCLUSION

Nanotechnology has revolutionized clinical dental practice. Nano materials have been playing a significant role in basic scientific innovation and clinical technological change of prosthodontics ranging from dental restorative materials to implants to surgical procedures to bone replacement material etc. Nano-technologies not only provide an alternative for dental treatment but some superior approaches in the prevention of diseases with the help of simple techniques and biocompatible materials. But there is a lack of studies addressing the safety and optimal concentrations of different nanoparticles in dental materials. A bright and successful future for nanotechnology will only be achieved through open sharing of ideas and more research work.

REFERENCES

[1]. Pradhan D, Pratik, Sharma L, Chaudri A. Nanotechnology: Future of Dentistry. Int J Oral Health Med Res 2017;3(6):134-136.
[2]. Erkoç Ş. Nanobilimve Nanoteknoloji. Bask, Ankara: ODTÜYayıncılık; 2007;1-10.

[3]. Gopinadh A, Prakash M, Lohitha K, Kishore KK, Chowdary AS, Dev JR. The changing phase of prosthodontics: Nanotechnology. J Dent Allied Sci 2015;4:78-83.
[4]. Jhaveri H.M., Balaji P.R. Nanotechnology: The future of dentistry. The Journal of Indian Prosthodontic Society | March 2005 | Vol 5 | Issue.
[5]. Rajan S.S. , Acharya S.R., Saraswathi V. NANODENTISTRY. Indian J.Sci.Res. 4(2) : 233-238, 2013.
[6]. Pal KS, Ranganath LM, Gaikwad AV, Sarapur S, Jain SK. NANOPARTICLES IN PROSTHODONTICS – BOON OR BANE. IJOCR Apr - Jun 2015; Volume 3 Issue 8.
[7]. Thomas B, Mathew CA, Muthuvignesh J. Nanotechnology- Applications in Prosthodontics: A Literature Review. Journal of Orofacial Research, April-June 2014, 4(2): 103-110.
[8]. Wang W, Liao S, Zhu Y, Liu M, Zhao Q, Fu Y. Recent Applications of Nanomaterials in Prosthodontics. Journal of Nanomaterials Volume March-2015.
[9]. UysalTancan, Yagci Ahmet, Uysal Banu and Akdogan Gülsen, 2010. Are nano-composites and nanoionomers suitable for orthodontic bracket. European Journal of Orthodontics ;78-82.
[10]. Yoshida K, Tanagawa M, Matsumoto S, Yamada T, Atsuta M. Antibacterial activity of resin composites with silver containing materials. Euro J Oral Sci 1999;107(4):29096.
[11]. Singhla G, Vaudeva K, Puri N. NANODENTISTRY- THE FUTURE AHEAD. BFUDJ Vol-1, No-1, July 2010.
[12]. Ki-Young Nam. In vitro antimicrobial effect of the tissue conditioner containing silver nanoparticles. J AdvProsthodont 2011;3:204.
[13]. Chandki R, Kala M, Kumar NK, Bright B, Bantia P, Banthia R. Nanodentistry- exploring the beauty of miniature. J ClinExp Dent 2012, 4(2); 119-124.
[14]. Han Y, Zhao Y, Xie C, Powers JM, Kiatamnuay S. Color stability of pigmented maxillofacial silicone elastomer: effects of nano-oxides as opacifiers. J Dent 2010;38(2):100-5.
[15]. Mantri SS, Mantri SP. The nano era in Dentistry. J NaturaalSci Bio Med 2013; 4(1): 39-44.