



Current applications of nanoparticles in preventive dentistry – A Literature review

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Abstract

Nanomaterials have significant and higher belongings such as higher area and nanoscale size which is superiorly higher and significant for quick diagnosis and advantageous in treatment of various diseases in the health sector. With the present available diagnostic methods and accurate methods so that many oral diseases can be treated at every starting stages.. Preventive dentistry is one among the most growing areas where nanotechnology shows its impact to improve people's dental needs which will improve the quality of life. The use of nanotechnology in curing oral diseases has discovered a huge interest. Its use has enlarged dentin hypersensitivity, root canal disinfection, and oral cancer to the most current use in tissue engineering and also in drug delivery applications. It aims not only to get control with a position which has a high degree of specificity and also to achieve the relevant physical and chemical properties. Mian significant finding of modern dentistry is to evaluate the diagnosis of any oral diseases and prevent at early stage itself. Through various techniques and methods like fluoridation, sealants have been used in preventing dental caries yet no huge improvement has not been made in history for prevention of dental caries. This paper reviews the current applications of nanoparticles in the field of preventive dentistry.

Key words: Dental caries, minimal invasive, Nanoparticles, Nanotechnology, Preventive dentistry.

Introduction:

The term nanotechnology has got its roots from a Greek word nanos which meant dwarf. Norio Taniguchi in 1974 introduced the term nanotechnology when mentioned a technique to get extra accuracy and lighter dimensions. ⁽¹⁾ . Nanotechnology as a teach has rapidly advanced into all divisions of science since it gives imperative ways to figure on logical

and restorative issues. Nanotechnology might be a department of innovation that performs backed measurements of but 100 nm. It incorporates objects from infections at around 100 nm estimate to glucose particles at around 1 nm. Nanomaterials have distinctive and higher properties such as increased surface area and nanoscale size which imparts a superiorly advanced and important for quick diagnosis and advantageous in treatment of various

diseases in the health sector.^(2,3) This field has been drastically making its impact in medicine and dentistry. Nanodentistry targets to guarantee comprehensive wellbeing of the understanding which leads to the essential anticipation of verbal illnesses. With the accessibility of progressed and exact symptomatic strategies, a number of verbal illnesses can be avoided or treated at early signs.

Preventive dentistry is one among the most growing areas where nanotechnology shows its impact to improve people's dental needs which will improve the quality of life⁽²⁾. Groundbreaking research in nanobiotechnology has guided the improvement of environmentally friendly nanofillers using “green chemistry”^(3,4). The challenge that every researcher/ dentist has is to find a composite or filler material which mimics the lost dentin and enamel tissue which are capable of the restoration of lost tissue. This mimicking procedure has been a new milestone in nano dentistry which paved the way to many new innovations in dentistry. Basically, oral microbial materials restrict the formation of biofilm on hard tissues in the oral cavity. Addition of elements like gold, silver or copper can definitely increase the antibacterial properties. This can even enhance the mechanical and physical properties too. Addition of antibacterial materials into dental composites and fillers can definitely increase their efficacy.

The utilize of nanotechnology in curing verbal infections has found a gigantic intrigued. Its utilize has extended dentin extreme touchiness, root canal sanitization, and verbal cancer to the foremost current use in tissue building conjointly in sedate conveyance applications. It can moreover be said that nanotechnology has been

utilized in dentistry for a few time, especially within the extension of therapeutic materials, with a few momentous victory. Analysts ought to overcome the control of the technical challenges of developing these materials to misuse the properties at the nanoscale. Other stages deliver a critical guarantee, imperatively within the avoidance and treatment of verbal biofilms. One critical point to note in destruction of biofilms is that essentially all medications have concentrated on the murdering of microbes within the biofilm but the microbes as it were account for as it were 20% of the mass of the biofilm. The adjust may be a polysaccharide network, and it may be reasonable to consider targeting this network, which clench the bacterial community in conjugation with instead of microbes themselves. Application of nanotechnology in different offices more for the most part in dentistry which gives exceptional openings as the required materials are restricted in their complexity and hence the restorative can be more promptly realized.

Basic developments of nanotechnology in dentistry:

Present nanotechnological process comes under two broad approaches. Top level approach was with the intensification of current materials and products where there already existing products and its structures were made into the smallest nano range but no compromise with its properties. Bottom level approach offers the innovation of new materials and products /devices where in their structural compounds are used to produce nano compounds^(5,6).

The field of dentistry is currently receiving unimaginable support from the

biotechnological sector, in the form of new innovations that include high technical diagnostic aids and treatment devices. Present dental research involves progressive growth into the preventive, diagnostic, reconstructive, regenerative, restorative, and rehabilitative domains of dentistry. For example: Nanofillers in restorative dentistry, dental implants in prosthodontics, Nanocrystals of CaSO₄ and nanoceramic composite materials in bone regeneration.^(7,8)

Applications of Nanotechnology in Dentistry:

Nanotechnology is apparently an innovative field, which includes manipulation of compounds at its molecular level, including single separate molecules and its interactions between them.⁽⁹⁾ It aims not only to get control with a position which has a high degree of specificity and also to achieve the relevant physical and chemical properties.^(10,11) There has been an increase in interest in reciprocating the property of the particular matter at the procured dimension, thus making nanotechnology one of the most promising areas of scientific innovation. These applications will make way for future research opportunities in device and drug development, thus increasing an era of unimaginable advances in dental diagnostics and therapeutics.⁽¹⁰⁻¹²⁾ When it comes to dentistry, the main purpose of modern dentistry was the early prevention of tooth decay rather than invasive restorative dentistry. Through various techniques and methods like fluoridation, sealants have been used in preventing dental caries yet no huge improvement has not been made in history for prevention of dental caries.⁽¹³⁾ The current applications of

nanotechnology in preventive dentistry have been reviewed in this article.

Dentifrices and mouthwashes:

Dentifrices and mouthwashes are the most commonly used products for plaque control. This can incorporate^(14,15) nanomolecules into daily used preventive measures will definitely be a milestone in preventive dentistry.⁽¹⁶⁾ For example during the formulation of dentifrice, certain agents which can prevent plaque and protect from dental diseases can be incorporated. This can also help us in remineralizing the demineralized carious surfaces of the tooth. This process can be made possible by incorporating apatite crystals. According to Nakashima et al⁽¹⁷⁾ dentifrice containing nanosized calcium carbonate crystals has made 48% remineralization in artificially made enamel lesioned surfaces. n-CAP. (nano hydroxyapatite crystals) is the similar inorganic material of teeth which also have high solubility and more neutral pH. But when compared with commercial agents n-CAP has been a proven efficacious short-term agent.

Mouthwash which contains triclosan and silver nanoparticles are the proven plaque control potential.⁽¹⁸⁾ This property was due to the high substantivity due to the use of bio adhesive polymers which have longer shelf life(2 years) and more homogenous particle size(250 nm). This makes a release system with control due to the existence of charged surfactant with bio adhesive properties on particle surface. This can be incorporated into toothpastes, gels and mouth rinses for the treatment and prevention.^(19,20)

Nanotechnology has also influenced the research in implant care and periodontology.^(21,22) A new innovative

mouthwash which contains biomimetic carbonate-hydroxyapatite nanocrystals has been proven to serve the titanium oxide layer which protects it against the oxidative process. This works on the principle in which the nanocrystals reduce the implant surface roughness by depositing hydroxyapatite on the titanium surface. Reduction in surface roughness prevents plaque accumulation and other pathologies.^(21–23)

Nanoparticles in nanocomposites:

Usually dental caries have been progressed by early microbial biofilms that formed on the tooth surface which leads to dental caries.⁽²⁴⁾ Incorporation of nano apatite particles into restorative materials can cause remineralization of lesion surfaces. Inclusion of amorphous calcium phosphate Nanoparticles (ACPnPs) in composite can cause remineralization of tooth minerals.^(25,26) These are composite tars which contain similarly disseminated nano-agglomerated nanoparticles. Aluminosilicate powder in which 1:4 proportion is the foremost commonly utilized filler, with a normal molecule measure of 80 nm. These nanofillers with a refractive list of roughly 1.503 which is preferences when compared with customary smaller scale filled and cross breed resin-bonded composite (RBC) frameworks. These nano filled composites have more prominent properties like polishability, smoothness, flexural quality, and color when compared to other back RBC.

Nano Light-curing Glass-Ionomer Restorative:

Nanoparticles joined into glass-ionomer cement (GIC) was to begin with created for Ketac™ Nano (3M ESPE, 3mespe.com)

with fluor aluminum-silicate innovation in a run of 1 μm. The expansion of nanoparticles can move forward esthetics and the polishability of the reclamation. Another nano filled light-cured varnish (G-Coat Plus™, GC Europe, gceurope.com) was connected onto the surface of gooey GIC (Fuji IX GP® Additional, GC Europe). Nanofillers which comes about in progressed wear resistance by maintaining a strategic distance from starting water admissions and parchedness and diminished introductory setting time.

Nanoparticles for prevention of oral biofilms:

For longer prevention of pathogenic intraoral biofilm formation, a wear resistant nanocomposite surface coating which is easy to clean with integrating nanometer-sized inorganic particles was developed.⁽²⁷⁾ These nanoparticles have 20–25 mJ m⁻² surface free energy which is known as theta surfaces. For high risk dental caries patients, it's easy to clean property is cherry on cake.⁽²⁸⁾ Possible application of these innovations would be tooth sealants as well as coatings of restorations, denture etc. Even tooth fissures which can be restored with this material can be cleaned conveniently by brushing forces. Other nano-enabled approaches for biofilm management are oral health-care products that contain bio inspired apatite nanoparticles, either alone or in combination with proteinaceous additives such as casein phosphopeptides.⁽¹⁷⁾

Biomimetic technique:

Remineralization techniques can't repair the enlarged carious or erosive enamel defects. The proper way to restore the enlarged clinical loss of enamel was to

apply the resin composites in addition with dental adhesives.⁽²⁹⁻³¹⁾ But this biomimetic technique of enamel would be a definite alternate synthesis which would repair and self-assemble hierarchical organized hydroxyapatite crystals.⁽³²⁾ To produce a technique many groundbreaking experiments were performed to mimic the microstructures which would form enamel using hydrothermal conditions.^(33,34) And also, several in vitro attempts have been made to create enamel-like structures which have nano- and microstructures using amelogenin to dominate the crystallization of biomimetic calcium and phosphate.⁽³⁵⁻³⁷⁾ Amelogenin oligomers arbitrate the self formed structures of a crystalline material which mimic the natural enamel without hydrothermal conditions.^(38,39)

Conclusion:

Nano Joined verbal wellbeing care items have driven its way from the research facility to ceaseless utilization affirmed by individuals for biofilm and plaque control , remineralization of demineralized surfaces and in consolidation in dentifrices. These applications will clear the way for advance investigate openings in gadget and medicate improvement, hence commencing an time of exceptional progresses in dental diagnostics and therapeutics. Assist inquire about on nanotechnology and antimicrobial materials has the potential of making strides therapeutics in dentistry. An broad sum of investigate within the advancement of exceedingly progressed, therapeutic nanomaterials is basic for its success in dentistry. Within the close future, this innovation may ended up the center of dental and restorative science and exact steps in this method can bring approximately favorable social, financial

and more beneficial verbal wellbeing results for individuals.

Conflicts of Interest: NIL

Ethical approval number: NA

Informed consent: NA

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