



NANODENTISTRY: A NEW DISCIPLINE OF DENTISTRY

Saima Mazhar^{*1}, Farzeen Tanwir^{1,2}, Natasha Zaidi³, Tauqeer Bibi⁴, Ahmed Bin Khalid Khan⁵ and Bushra Ijaz⁶

^{1,3,4,5,6}Department of Periodontology Dentistry, Bahria University Dental College.

²Faculty of Dentistry McGill University, Montreal, Quebec.

***Corresponding Author: Saima Mazhar**

Department of Periodontology Dentistry, Bahria University Dental College.

Article Received on 28/11/2022

Article Revised on 18/12/2022

Article Accepted on 08/01/2023

ABSTRACT

The scientific approach of altering the properties by manipulating a material in nanoscale is termed as Nanotechnology. This rising fashion in the discipline of periodontics, dentistry has made approaches much less invasive via means of methods of nanorobots, nanomaterials, nanodiagnostic aids and nanotherapeutic approaches. Nanodentistry seems to be extra promising in dentistry for protection of good oral care. Nanotechnology has revolutionized cutting-edge diagnostics.^[1] The aim of this review paper is to focus on application of nanotechnology in dentistry in recent years and forecast trends in this field that may help in planning further scientific research. Nanotechnology has mounted its presence in genuinely all domains of science and technology. Its packages in healthcare extensively vary from superior diagnostics to biosensors and centered drug delivery. This is due to the fact nano materials have precise size-established homes that extensively enhance human existence and fitness when exploited. Dentistry has consequently shown visible profound developments especially in the last decade, with the involvement of such nano materials and technology. The wide variety of dental nano materials available had risen with time and a huge variety of them were researched for industrial and scientific usage. For example, antimicrobial nanoparticles are being applied in restorative composite fabric for the prevention of dental caries. Incorporating nano materials into preexisting dental materials has increased their biocompatibility. It is predicted that in the near future, nanotechnology may also permit the restore and rebuilding of dental tough tissues.^[2]

KEYWORDS: Nanotechnology, Nanorobots, Nanomaterials, Nanoparticles, Nanodentistry.

INTRODUCTION

Nano implies Dwarf in Greek. Nano is the smallest unit of estimation, which is approx 1/80000 of the human hair diameter. Nanodentistry was right off the bat presented by researcher Frietas in 2000.^[3] Nanotechnology can be characterized as an innovation that arrangements with little designs or little measured materials.^[4] Nanodentistry has made it workable for individuals to emerge from dread and tension to visit the dental specialist. This new discipline of dentistry can be utilized to analyze, fix, and forestall oral and dental issues, and to alleviate torment and keep up with and improve dental wellbeing.^[5] Nanodentistry includes three branches-nanorobotics, nanodiagnosics and nanomaterial. This innovation is currently generally utilized wherever be it clinical, designing, and so on. Many investigations have been completed in regards to this space up until this point. In this survey, we will focus on the ongoing status of nanotechnology in the field of dentistry with its conceivable applications. Nano dentistry works with quicker and to the mark of exact analysis. It gives upgraded properties to the dental materials, which works

with incredible taking care of properties resulting in making the material more sturdy. It gives unrivaled hardness and expanded flexural strength.^[6]

Applications of Nanodentistry

Nanotechnology in field of dentistry is correlated and broad research has been conducted. Nanodentistry has been incorporated to different ideas inside dental field, as implantology, dental biomaterials, dental instruments, bone recovery, analytic devices for oral pathology.^[7] Nano dentistry in organization of nearby sedation is useful by setting up a colloidal suspension of miniature measured pain relieving dynamic particles. In the wake of interacting with the surface, these Nano robot particles whole by means of the gingival sulcus or the dentinal tubules and arrive at the ideal area. Dentin Hypersensitivity can be relieved by utilizing gold nanoparticles. These nanoparticles structure the littlest fillings and are utilized to fill the impacted dentinal tubules.

Nanomedicines utilized as dental materials have extraordinary physicochemical and organic properties that can be utilized to defeat the difficulties related with more conventional dental treatments.^[8] Damaged dental tissues can prompt dental caries, periodontal sickness, tooth awareness, terrible breath, and oral precancerous and harmful circumstances. These can be relieved by restorative mediation and utilization of biocompatible engineered materials.

Implantology and Prosthodontics

While taking impression, noting each of the subtleties precisely with practically no voids is vital particularly when a prosthetic substitution must be given.

Nanofillers are incorporated alongside the regular impression materials to improve the properties of the material. This forestalls the arrangement of voids in the impression and it has better stream properties.^[9] Recently, even nanostructured earthenware production are being created. This prompts an expanded strength of the clay as well as toughness.^[10] Nanotechnology incorporated in dental implantology can work with the use of mineral substance of the bone as a covering over the embed which gives improved outcomes.

Periodontology and Nanodentistry

Ongoing advancements in areas of Nanotechnology and Nanodentistry have been helpful in different treatment processes across various fields, including Periodontics. Nanocomposites has been monitored in the event that they can be ideal medication conveyance frameworks to make due periodontal illnesses. Nanoparticles and different dentifrices are being used in this field.^[11]

Orthodontics

In orthodontics, these nanorobots work with direct control of the place of the Tooth ensuring the treatment fast and effortless. In the field of Orthodontics, Nanotechnology has been created to work on holding of orthodontics.^[12] Nanoparticles have a scope of exercises like mitigating, hostile to microbial, against cariogenic. Through orthodontic ligatures the nanoparticles can be conveyed as medicaments.^[13]

Operative Dentistry

The properties of nano fillers are improved when added to impression materials and this Results in lesser voids in recording of impression. Nanoparticle consolidated composites depict improved properties of prevalent hardness and expanded flexural strength. This works with a better capacity to clean the composite and achieve a superior tone for the tooth.^[14]

In the field of Endodontics nanotechnology can be used broadly. It can more precisely be applied in fillers, irrigants, and composites to produce improved results.

Oral Medicine

It can be utilized to manage oral malignant growth through utilization of nanoshells which manufacture heat and afterward specifically obliterate the malignant growth/malignant cells. In oral wellbeing, Nano particles in dentistry incorporates techniques that depend on nanotechnology. This is finished through indicative and remedial strategies. Nanodentistry will make it conceivable to give likely treatment open doors fitting the necessities of the specific case. Regulating local can be utilized sedation or be an extremely durable fix to touchiness.

Nano-dentistry and prevention

To prevent biofilm-subordinate oral infections is the motive of modern dentistry, such as dental caries, endodontic conditions, and periodontal diseases, rather than to treat them. New methods for preventing oral disorders, particularly tooth caries and periodontal diseases, are provided by nanotechnology.^[15] Among primary way for reducing the prevalence of this illness is caries prevention. The methods for preventing dental caries are constantly being improved, but the most practical tool is still the use of preventive and restorative toothpastes. Even routine brushing can now provide cleanliness and protection of the oral cavity at the nano level thanks to advancements in dental nanotechnology. Nano toothbrush is introduced by researchers. Counting colloidal nanogold or nanosilver particles between toothbrush fibres.^[16-17] can significantly reduce periodontal disease. The necessary component of mouthwashes, nanocalcium fluoride, lowers the action of caries, reduces dentin porousness, and expands the labile convergence of fluoride in oral liquid.^[18] In comparison to ordinary toothpaste without nano-added materials, toothpastes containing calcium carbonate nanoparticles and 3% nanosized sodium trimetaphosphate promote remineralization of early carious injuries.^[19]

Use of Technologies Concerned To Nano Particles in Diagnosis of Patients

Not only for the prevention and treatment of dental diseases nanoparticles are used, but also as experts in other research outcomes. Due to the optical uniqueness of transillumination, "laser detection" of caries has become the most recent buzzword in dental innovation.^[20]

Other applications

Different applications that dental scientists are at present investigating include

- Endodontic treatment
- Forestalling dental caries
- Mix with dental inserts
- Treating periodontal infection
- Screws for bone obsession
- Direct mash covering methods
- Dentin recovery
- Improved bone recovery
- Creating counterfeit mucosa

Finally, and maybe most excitingly, nanodentistry can be used in the therapy of oral malignant growth. Little globules known as nanoshells produce heat through radiation and specifically obliterate disease cells while letting solid cells be. It sounds unrealistic, however it's the truth of nanodentistry today.^[21]

Mouth washes and toothpastes are now accessible which depend on nanoscaled mineral content or even simply nanoparticles.^[22] Engineered Nanomaterials can have various advantages. They can be utilized to fortify the design of the tooth and furthermore go about as against bacteria to give contamination control. Nanofillers additionally work on the nature of supportive dental materials.^[23]

Additional benefits and safety issues of dentistry related to nano particles

Nanotechnology includes the utilization of nano-organized materials that are applied in Dentistry, to accomplish improved results.^[24] Nanomaterials have acquired significance on account of their various applications in various areas of science.^[25] According to current exploration that shows that the utilization of nano particles in field of dentistry will upgrade the nature of consideration related to dentistry. With help of nano dentistry it will be conceivable to keep up with oral wellbeing as near amazing as conceivable using nanomaterials.^[26]

Nanotechnology plays its part in each field and it can make our life simple and quicker. Be that as it may, it has not many constraints connecting with our security concerns. Nanomaterials have enormous surface region volume proportion because of which molecules present at the surface likewise increment. Consequently, nanomaterials are more receptive and have expanded pace of ingestion through skin, lungs, and intestinal system. Consequently after a drawn out use, these will get collected in various organs and will be shipped to different organs through blood. In the lungs, they might cause irritation of the alveoli and resulting cell harm. These little particles can likewise respond with DNA, RNA, and other intracellular parts and can cause mutations.^[27]

Potential Harm

Nanoparticles might actually hurt in the field they are utilized in. This is on the grounds that their properties are reliant upon their size. A molecule could result harmful as its size diminished from 100nm to 1nm. As an end result it will incite poisonousness and truly hurt the patient. The response of the patient's body to the nano materials is unusual. It might cause touchiness or unfriendly impacts which can't be anticipated ahead of time. Another conceivable mischief is that these nano estimated particles can be breathed in or consumed by the patient. These can cross cell layers and arrive at the liver and achieve serious damage.^[28]

Future Scope

At this point, the utilization of nanotechnology is restricted to the accessible wellsprings of materials. More advancements which will prompt improved results will be conducted in future. What's to come use of nanotechnology will yield improved brings about progress of oral wellbeing status.^[29] In the forthcoming years, perhaps nanotechnology in dentistry will find actual success in organization of medications and giving quality treatment when required.^[30] The fate of dentistry is Nanodentistry. Dental specialists on the whole trust that inside 10-20 years, nanorobots will be sufficiently effective to precisely give analysis. Further examination ought to be directed in Nanodentistry to guarantee a proficient medication conveyance framework, decrease the poisonous impacts that are caused. Nanotechnology can likewise be utilized in various fields like business, biomedicines and food. Nanotechnology can achieve a significant transformation in the medical services area, particularly in the field of dentistry.^[31]

Researchers are confident that nanodentistry will change the typical individual's perspective on the dental specialist, which is much of the time negative and brimming with dread and worry. Since it is finished on a limited scale, nanodentistry supports negligibly intrusive methodology. Researchers anticipate that this should make a more dental specialist accommodating air after some time. Moreover, nanodentistry - and explicitly the utilization of nanoparticles - considers a phenomenal degree of accuracy in diagnosing, treating, and forestalling dental sicknesses. That implies improved results for patients and their doctors. In the event that this new kind of innovation keeps on progressing at a similar rate, it makes certain to protect and work on human wellbeing as a whole.^[32]

CONCLUSION

Nanodentistry is another methodology. To improve the qualities of the materials of dentistry, it incorporates advanced nanotechnology strategies with conventional materials.

It has been shown that using nanotechnology in dentistry can improve the qualities of current materials of dentistry and give additional outcomes. Given its enormous potential, the future of nanodentistry is exceedingly bright. The sufferers will experience greater fulfilment as a result. This is due to the improvisation of the qualities of materials to produce greater outcomes compared to ones using the conventional materials. The majority of research into applied nano dentistry is still in its early stages, which represents a significant portion of its development. Despite this, the rate of advancement of nanotechnology is encouraging, and new applications are anticipated.

Contributions by Authors

Equal contribution is being done by all the authors.

Conflict of Interest

Authors declare no conflict of interest of any kind.

REFERENCES

- Kanchi, S.; Sharma, D. (Eds.) *Nanomaterials in Diagnostic Tools and Devices*; Elsevier: Amsterdam, The Netherlands, 2020
- Sen D, Patil V, Smriti K, Varchas P, Ratnakar R, Naik N, Kumar S, Saxena J, Kapoor S. *Nanotechnology and Nanomaterials in Dentistry: Present and Future Perspectives in Clinical Applications*. Engineered Science, 2022 Apr 29; 20.
- Freitas RA. *Nanomedicine, volume I: basic capabilities*. Georgetown, TX: Landes Bioscience, 199.
- G. Cao, Y. Wang, *Nanostructures and nanomaterials*, 2nd ed.), World Scientific, New Jersey, 2011.
- Mantri SS, Mantri SP. The nano era in dentistry. *Journa of natural science, biology, and medicine*, 2013 Jan; 4(1): 39.
- Ahmed W, Elhissi A, Dhanak V, Subramani K. Carbon nanotubes: Applications in cancer therapy and drug delivery research. In *Emerging nanotechnologies in dentistry* William Andrew Publishing, 2018 Jan 1; 371-389.
- Thomas B, Mathew CA, Muthuvignesh J. Nanotechnology—Applications in Prosthodontics: A Literature Review. *Journal of Orofacial Research*, 2014; 103-10.
- P. Schexnailder, G. Schmidt *Nanocomposite polymer hydrogels* *Colloid Polym. Sci.*, 2009; 287: 1-11.
- Boora P, Rathee M, Bhorla M. Effect of platelet rich fibrin (PRF) on peri-implant soft tissue and crestal bone in one-stage implant placement: a randomized controlled trial. *Journal of clinical and diagnostic research: JCDR.*, 2015 Apr; 9(4): ZC18
- Jayakaran TG, Arjunker R. Nanocomposite hydrogels as local drug delivery in periodontics. *Journal of Pharmaceutical Sciences and Research*, 2013 Dec 1; 5(12): 277.
- Gentiluomo L, Svilenov HL, Augustijn D, El Bialy I, Greco ML, Kulakova A, Indrakumar S, Mahapatra S, Morales MM, Pohl C, Roche A. Advancing therapeutic protein discovery and development through comprehensive computational and biophysical characterization. *Molecular Pharmaceutics*, 2019 Dec 2; 17(2): 426-40.
- Subramani K, Subbiah U, Huja S. Nanotechnology in orthodontics—1: The past, present, and a perspective of the future. In *Nanobiomaterials in clinical dentistry*, 2019 Jan 1; 279-298.
- Kudva IT, Hovde CJ, John M. Adherence of non-O157 Shiga toxin-producing *Escherichia coli* to bovine recto-anal junction squamous epithelial cells appears to be mediated by mechanisms distinct from those used by O157. *Foodborne pathogens and disease*, 2013 Apr 1; 10(4): 375-81.
- Zhou, L.; Wong, H.M.; Li, Q.L. Anti-Biofouling Coatings on the Tooth Surface and Hydroxyapatite. *Int. J. Nanomed*, 2020; 15: 8963.
- AlKahtani, R.N. The implications and applications of nanotechnology in dentistry: A review. *Saudi Dent. J.*, 2018; 30: 107–116.
- Al-Ajely, M.S.; Ziad, K.M.; Al-Bader, R.M. Preparation and characterization of calcium fluoride nano particles for dental applications. *Int. J. Res. Granthaalayah*, 2018; 6: 338–346. [CrossRef]
- Emerenciano, N.G.; Delbem, A.C.B.; Pessan, J.P.; Nunes, G.P.; Neto, F.N.S.; de Camargo, E.R.; Danelon, M. In situ effect of fluoride toothpaste supplemented with nano-sized sodium trimetaphosphate on enamel demineralization prevention and biofilm composition. *Arch. Oral Biol.*, 2018; 96: 223–229.
- Jones, N.A.; Chang, S.Y.; Troske, W.J.; Clarkson, B.H.; Lahann, J. Carious Lesions: Nanoparticle-Based Targeting and Detection of Microcavities. *Adv. Healthc. Mater*, 2017; 6: 1600883.
- Zhou W, Liu S, Zhou X, Hannig M, Rupf S, Feng J, Peng X, Cheng L. Modifying adhesive materials to improve the longevity of resinous restorations. *International Journal of Molecular Sciences*, 2019 Feb 8; 20(3): 723.
- Kim S. Les besoins mathématiques des non-mathématiciens: quel destin institutionnel et social?: études d'écologie et d'économie didactiques des connaissances mathématiques (Doctoral dissertation, Aix-Marseille).
- <https://richmonddental.net/library/nanodentistry-what-is-it-how-is-it-changing-the-field-of-dentistry/>
- De Souza Rastelli AN, Carreira ET, Dias HB, Hamblin MR. Nanobiomaterials in dentistry. In *Nanobiomaterials in Dentistry* William Andrew Publishing, 2016 Jan 1; 1-25.
- Bechavod Y, Ligett K. Penalizing unfairness in binary classification. *arXiv preprint arXiv:1707.00044*, 2017 Jun 30.
- Kumar PS, Kumar S, Savadi RC, John J. Nanodentistry: A paradigm shift-from fiction to reality. *The Journal of Indian Prosthodontic Society*, 2011 Mar; 11(1): 1-6.
- Alkahtani MH, Alghannam F, Jiang L, Almethen A, Rampersaud AA, Brick R, Gomes CL, Scully MO, Hemmer PR. Fluorescent nanodiamonds: past, present, and future. *Nanophotonics*, 2018 Aug 1; 7(8): 1423-53.
- Ozak ST, Ozkan P. Nanotechnology and dentistry. *European journal of dentistry*, 2013 Jan; 7(01): 145-51.
- Upadhyay Y. Current state and future perspectives of nanotechnology in dentistry. *Int Organ Sci Res J Pharm*, 2013; 3: 68–71.
- Kumar SR, Vijayalakshmi R. Nanotechnology in dentistry. *Indian J Dent Res.*, 2006 Apr 1; 17(2): 62-5.

29. Smitha B, Naik S. Nanodentistry-Small wonder in dentistry. *Journal of Indian Association of Public Health Dentistry*, 2011 Nov 1; 9(18): 701.
30. Verma S, Chevvuri R, Sharma H. Nanotechnology in dentistry: unleashing the hidden gems. *Journal of Indian Society of Periodontology*, 2018 May; 22(3): 196.
31. Kena G, Aud S, Johnson F, Wang X, Zhang J, Rathbun A, Wilkinson-Flicker S, Kristapovich P. The Condition of Education 2014. NCES 2014-083. National Center for Education Statistics, 2014 May.
32. <https://richmonddental.net/library/nanodentistry-what-is-it-how-is-it-changing-the-field-of-dentistry/>