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Original Research

Knowledge and Assessment of Endodontists in the Field of Nanotechnology in Endodontics: A Qualitative Research

Izaz Shaik[1], Supriya Goyal[2], Siddhartha Bhowmick[3], Shilpa Vikranth Shetty[4], Vikranth Shetty[5], Shivam Sharma[6], Shalini Singh[7]

[1]MDS, DMD student, Rutgers School of Dental Medicine, Newark, New Jersey, USA;
[2]BDS, Gian Sagar Dental College , Baba Farid University of Health Sciences, Faridkot, Punjab, India;
[3]MDS, Senior Lecturer, Dept of conservative dentistry and endodontics, Awadh Dental College and hospital Jamshedpur, Jharkhand, India;
[4]MDS, Reader, Department of conservative dentistry and endodontics, Tatyasaheb Kore Dental College and Research Centre, new pargaon, Kolhapur, Maharashtra;
[5]MDS, Professor, Department of Orthodontics, Tatyasaheb Kore Dental College and Research Centre, New Pargaon, Kolhapur, Maharashtra;
[6]JR III, Dept Of Cons and Endodontics, Chandra Dental College And Hospital, Barabanki, Uttar Pradesh;
[7]MDS, Assistant Professor, Department of Conservative Dentistry & Endodontics, Dr. H.S.R.S.M. Dental College & Hospital, Hingoli, Maharashtra

ABSTRACT:
Aim of the study: The purpose of the study is to understand and assess the knowledge of Nanotechnology used in Endodontics and how they can be helpful in ensuring proper prevention and treatment of endodontic cases. **Methodology:** A questionnaire survey was conducted amongst 45 Endodontists who had more than a year of clinical experience. The questions were based on usage of Nanoparticles as well as its contribution in the field of dentistry particularly in cases of root canal therapy. **Results:** Around 56% believed that adding nanoparticles to biomaterials especially used in restoration of teeth would prove helpful as these would increase the flexural strength as well as improve the abrasion resistance and around 67% believed that adding nanoparticles especially to composite restorative material reduced polymerization shrinkage considerably. **Conclusion:** Nanoparticles-based treatment strategies have the potential to improve antibacterial/antibiofilm efficacy in endodontics. Thus, the increasing interest in this field warrants sound research based on scientific and clinical collaborations to emphasize the future potential of nanoparticles in clinical endodontics.
Key words: Nanotechnology, disinfectant, nanobioparticles, endodontics.

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Corresponding Author: Dr Izaz Shaik, MDS, DMD student, Rutgers School of Dental Medicine, Newark, New Jersey, USA, India

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INTRODUCTION

Nanotechnology has revolutionized all aspects of health including the dentistry. It is the science of producing functional materials and structures in range of 0.1 nm to 100 nm.[1] The term was coined by Prof. Kerie E. Drexeler, in 1980's derived from Greek word which means 'dwarf".[2] The purpose of Nanodentistry is to maintain the near-perfect oral health through the use of nanomaterials including tissue engineering and nanorobotics.[3] The scope includes a wide variety of oral health-related issues such as treatment of biofilm elimination, diagnosis dentin hypersensitivity, and oral cancer. In the field of endodontics, the nanomaterials are focused on steps that would improve mechanical integrity, antimicrobial of previously diseased tissue regeneration, and dentin matrix. Currently, it is a new technology tested in endodontics to have challenges over microorganism.[4] Endodontic instruments, both hand- held and engine-driven, are available for root canal preparation. Since

the early 1990s, with the advent of nickel-titanium, various instrument designs and modalities have been produced in this regard.[5] Surface quality is an important factor in the function and durability of NiTi instruments and superficial defects such as metal flash, roll over and cracks may lead to the instrument fracture.[6] Electro polishing the surface and coating it with titanium nitride have been recommended for promotion of the surface quality.[7] Currently, nanomaterials, with a smaller size, are being suggested for surface modification and reduction the incidence of failure in the rotary nickel-titanium files.[8] Nanotechnology can be applied in other areas of dentistry as well, such as diagnosis of diseases, treatment, and prevention.[9] For instance, Monfared et al. conducted a study on the effect of nano particles on the filling composite used for restoration. It was observed that adding glass nano particles into the composite enhanced its mechanical properties.[10] In another research, Kim et al. investigated the influences of using nano-carbonate apatite on the re-staining after bleaching. Obtained results revealed that employing 10% nano-carbonate apatite led to lower color difference.[11] Han et al. carried out a study on the influences of nano-oxides on the stability of the color of pigmented maxillofacial silicone elastomer. Among nano particles tested in the study, including and, using resulted in the lowest color change.[12] Adding nano-sized materials to the toothpaste can augment toothpaste characteristics such as its remineralizing influence of artificial caries lesions.[13] Other specifications of toothpaste can also be improved by using nano materials. Santos Jr et al. investigated a novel anti-caries agent, known as nano silver fluoride, in order to arrest caries in a group of children. The nano silver fluoride was used once a year in the study. The results indicated that, at seven days, 81% of investigated teeth in the group which utilized nano silver fluoride showed arrested caries, while there was no tooth arrested in the control group. As a consequence, it was concluded that the nano silver fluoride is appropriate for arresting dentine caries which were active. [14] Silver compounds and nanoparticles which are used in biomedicine, mainly because of their antibacterial property.[15] In case of dental application, silver and its nanoparticles have been tested for application as endodontic retrograde filling material, dental restorative material, dental implants, and caries inhibitory solution.[16] Silver is known to produce an antibacterial effect by acting on multiple targets starting from interaction with the sulfhydryl groups of proteins and DNA, alter the hydrogen bonding/respiratory chain, unwind DNA, and interfere with cell wall synthesis/cell division. Ag-NPs with significant antibacterial activity could be used for root canal disinfection.[17] Bioactive Glass (BAG) received most considerable interest mainly due to its antibacterial properties and osteoinductive effect toward various orthopedic and dental applications. The antibacterial activity of BAGs has been investigated has three different approaches. BAG consists of CaO_2, SiO_2, Na_2O, and P_2O_5 at different and depends on the local physiological changes for its antibacterial effects. BAGs in micro-and nanoforms have been tested to improve root canal disinfection.[18] Chitosan (CS) has a similar structure to extracellular matrix components and is therefore used to reinforce the construction of collagen. Nanoparticles (NPs) of chitosan could be synthesized or assembled using various methods depending on the physical characteristics or end of application required on the nanoparticles. CS-NPs have been developed mainly for drug/gene delivery applications and antibacterial.[4]

AIM OF THE STUDY

The purpose of the study is to understand and assess the knowledge of Nanotechnology used in Endodontics and how they can be helpful in ensuring proper prevention and treatment of endodontic cases.

METHODOLOGY

A questionnaire survey was conducted amongst 45 Endodontists who had more than a year of clinical experience. The survey comprised of questions which were in an open-ended format and in English language. These were sent to survey participants via Email and their responses were recorded on a Microsoft Excel sheet and then analyzed with the help of descriptive statistics. The questions were based on usage of Nanoparticles as well as its contribution in the field of dentistry particularly in cases of root canal therapy.

RESULTS

The survey participants included were 15 female and 30 male endodontists. Out of all the survey endodontists around 76.8 % felt that nanotechnology is the future in dentistry but others felt that it is far from reach of developing nations. Around 56% believed that adding nanoparticles to biomaterials especially used in restoration of teeth would prove helpful as these would increase the flexural strength as well as improve the abrasion resistance and around 67% believed that adding nanoparticles especially to composite restorative material reduced polymerization shrinkage considerably. (**Table 1**) Around 89.5 % endodontists believe that a lot of expertise might be required in using nanotechnology especially in clinical settings rather than academic purposes as it might add to the cost of the treatment which will affect the patients in turn and they might raise certain biocompatibility as well as ethical issues.(**Table 2**) Furthermore, even the regeneration of necrosed pulp fibroblasts which few studies have indicated using nanoparticles requires more studies to validate the same. So, it is all the more imperative to make Nano-dentistry much more approachable in terms of technique sensitivity as well as cost effective.

Table 1- Advantages of Nanotechnology in Dentistry especially Endodontics according to survey participants.

Increased strength in restoration materials	56%
Better disinfectants for root canal irrigation	34.8%
Better flexural strength in cements	21%
Increased abrasion resistance	45%
Reduction polymerization shrinkage of resin restorative materials	67%
Prevent sealer leakage in root canal therapy	16%

Table 2- Problems faced with Nano-dentistry according to survey Endodontists.

Increased cost	95%
Biocompatibility issues	15%
Ethical concerns	10%
Complicated procedures	23%
More training/expertise required	89.5%

DISCUSSION

Nanotechnology has been growing in recent years due to its ability to enhance the performance of various systems. There are several studies which have focused on the applications of nanotechnology in engineering fields. In addition to engineering systems, nanotechnology can be applied in medical sciences. By applying nanotechnology, better treatment will be achievable. Nanotechnology provides the possibility of decreasing the size of devices and increasing the strength of materials, which makes tools more appropriate for utilization in medical devices.[19] Most of the nanoparticles were tested for root canal disinfection depends on time-dependent and contact-mediated antibacterial activity. Adding of various nanoparticles into root filling materials sealers or significantly improved the antibacterial efficacy by inhibition of biofilm formation on the surface as well as the resin-dentin interface.[4] The nanometric BAG used by Zehnder et al. were amorphous in nature, ranging from 20 to 60 nm in size. In vitro root canal disinfection studies showed a significantly less antibacterial effect of BAG compared with calcium hydroxide in preventing residual bacterial growth. Waltimo et al. suggested that an ideal preparation of 45S5 BAG suspensions/slurries for root canal disinfection should combine a high pH induction with a capacity for continuing release of alkaline species. Despite the higher specific surface area of nanometric BAG, the micrometric counterpart had a considerably higher alkaline capacity and eliminated biofilms significantly better. Another popular nanoparticle Chitosan, has excellent antiviral, antibacterial, and antifungal properties. In case of bacteria, Gram-positive bacteria which are more susceptible than Gram-negative ones. CS-NPs by virtue of their size and charge are expected to possess enhanced antibacterial activity.[18] Nanotechnology can be used to enhance the quality of the cement utilized as filler in endodontics. Hosseinzade et al. Conducted a study on the physiochemical properties of various dental cements. The cements investigated in the study were Calcium Enriched Mixture (CEM), Mineral Trioxide Aggregate (MTA), calcium phosphate hydroxyapatite and nano hydroxyapatite-chitosan. Other types of nano particles have been used as sealer to prevent leakage in the procedure of root canal therapy.[19] In another study, Javidi et al. utilized nano- zinc oxide nano-powder and compared its leakage with AH26 and micro size zinc oxide eugenol sealer. Their results indicated that zinc oxide nano-powders had the lowest micro-leakage among the investigated sealers; as a consequence, these types of sealer were appropriate for root canal therapy. The lower leakage of the sealer with smaller particle size was attributed to the effective surface. Since increase in particle size results in reduction of effective surface, smaller size of nano particles is more favorable to prevent leakage.[20] Nanotechnology is able to enhance the mechanical strength of various materials. This ability can be applied in order to enhance mechanical properties of the materials utilized in root canal therapy. In addition to enhancement in mechanical properties of materials used in endodontics, nanotechnology has been employed in order to decrease setting time of endodontics materials. Based on a study carried out by Akbari et al. adding silica nano particles to the mineral trioxide aggregate (MTA) resulted in faster hydration and decrease in setting time without any unfavourable influence on the flexural and compressive strength of MTA.[21] Nanotechnology is applicable to novel endodontics treatment method such as photodynamic therapy. Photosensitizer based on nano-particles can augment antimicrobial ability of photodynamic therapy. using the nano-particles which was encapsulated with photoactive drugs could be a favourable supplement in antimicrobial endodontic therapy. In addition to improvement in antimicrobial effectiveness of photodynamic therapy, some nano-particles have been used in photosensitizers to enhance their stability and make them more appropriate for treatment process.[19] Non-agglomerated discrete nanoparticles are homogenously distributed in resins or coatings to produce nanocomposites. The nanofiller used includes an alumino silicate powder having a mean particle size of 80 nm,1:4 ratio of

alumina to silica and a refractive index of 1.508. These nanocomposites offer superior hardness, flexural strength, modulus of elasticity and 50% reduction in polymerization shrinkage. Even nanoparticles which can be used in bonding agents. This ensures homogeneity and adhesive is perfectly mixed every time. Nanofillers are also integrated in vinylpolysiloxanes, producing unique additions of siloxane impression materials, having better flow, improved hydrophilic properties and enhanced details. A new organically modified ceramics based on sol-gel synthesis called Ormocers are also widely used in nanocomposite restorative systems. The particles are silicones, organic polymers, and ceramic glasses that are applicable to dental composites and the nanoparticle fillers are ZrO2.[22] Although nanotechnology appears to introduce ground breaking techniques and devices in the dental field, there are some concerns as well. These include economical nanorobot mass production technique, ethical issues and human safety, biocompatibility issues and the expertise in precise positioning and technique. Nanotechnology is foreseen to change health care in a fundamental way by providing novel methods for disease diagnosis and prevention, therapeutics selection, tailored to the patient's profile, drug delivery and gene therapy.[22]

CONCLUSION

Nanoparticles-based treatment strategies have the potential to improve antibacterial/antibiofilm efficacy in endodontics. Thus, the increasing interest in this field warrants sound research based on scientific and clinical collaborations to emphasize the future potential of nanoparticles in clinical endodontics.

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