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Awareness of Use of Implant Coated with Nanoparticles with Antimicrobial Properties

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ABSTRACT

Nanoparticles are nowadays widely used in dentistry. They have an essential role in the prevention diagnosis and treatment of the patients. There are different types of novel approaches in the use of nanoparticles in dentistry. Introduction of nanorobots has wider benefits and has consequently led to other major uses of nanoparticles in different aspects of dentistry. Nanomaterials have further been used in delivering oral fluid or drugs, preventing and curing some oral disease and maintaining oral health care up to a great extent. The objective was to review their use in nanocomposites, implant coatings, its antimicrobial activity against cariogenic pathogens, periodontal biofilm, fungal pathogens and endodontic bacteria and other applications such as treatment of oral cancer and local anaesthesia. This survey consisted of 200 participants, and the structured questionnaire was circulated through online access. A set of 15 questions about the basic idea, knowledge and awareness about the implant coated with nanoparticles was prepared and circulated, and the results were analyzed. Development of modified nanoparticles is surely going to help in our practice. Therefore it is essential to create awareness about the implant coated with nanoparticles with antimicrobial activity. This article summarises the benefits of using implants coated with nanoparticles over the conventional implants and its awareness among the practitioners.

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INTRODUCTION

Nanotechnology has paved the way for newer alternative techniques and a possibly superior approach for the identification of oral health-related problems. The term Nanodentistry was Coined by R.A. Freitas Jr. in the year 2000. Nanodentistry deals with diagnosing, treating, preventing dental diseases and improving oral health by using nanomaterials. Synthesis of biomaterials incorporated with nanoparticles is the latest research being undertaken with coverage of nano-related articles and patent applications (Sriram *et al.*, 2016). Nanodentistry is based on

the four novel approaches, which include top-down approach, bottom-down approach, functional approach and biomimetic approach (Jimbo *et al.*, 2014). Researchers have predicted that nanotechnology will become a vital part of future dental and periodontal health. The growing interest in nano dentistry is leading to the emergence of using Nanorobots in dentistry (Chandki *et al.*, 2012).

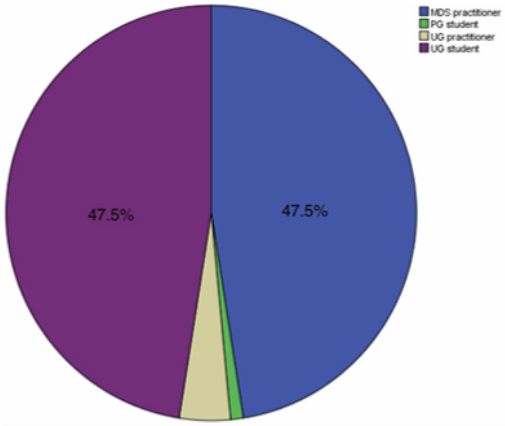

Figure 1: Pie chart representing the qualification of the participants

Various possible uses of nanorobots in dentistry include improved tooth durability and appearance, nanocomposites, Nanorobotic dentifrice (Dentifrobots), Nano impression, Dentin hypersensitivity, Orthodontic treatment and Inducing Oral Anaesthesia. Nanodentistry might help in the maintenance of oral health.

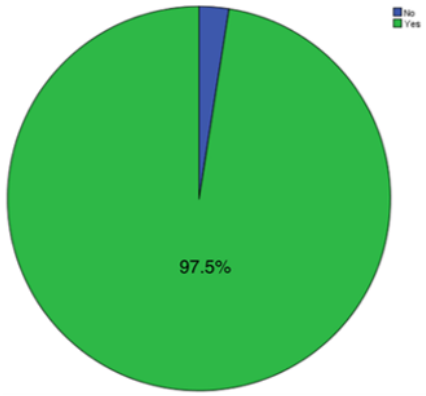

Figure 2: Pie chart representing the awareness of the word nano dentistry among the participants

It enables precise, controlled oral analgesia, dentine replacement therapy, permanent hypersensitivity cure, complete orthodontic realignment and other uses (Bilous, 2018). Nanoparticles are now widely used in impregnated gingival retraction cord which is typically an effective method to provide a clear working view of the tooth (Kannan and Venugopalan, 2018). Hence Diagnosis and treatment will be customized to match the preferences and genetics of each patient. Treatment options will become much diverse and exciting (Hamouda, 2012).

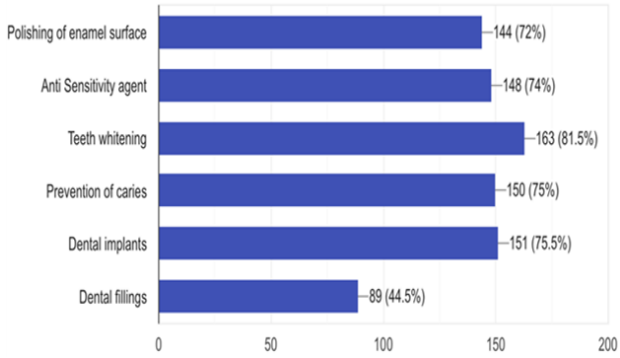

Figure 3: Bar chart representing the aspects of dentistry that use nanoparticles

Nanoparticles have been extensively studied for their uses in oral disease preventive drugs, prostheses and teeth implantation. Implant coated with nanoparticles was brought into dental practice to overcome the defects caused by the conventional implants. Different nanoparticles used in various applications of dentistry include carbon-based NPs, hydroxyapatite, silica, iron oxide, zirconia, silver, titanium etc. Some of the nanoparticles have antimicrobial activity, potency to control biofilm formation and anti-cariogenic activity (Parnia *et al.*, 2017).

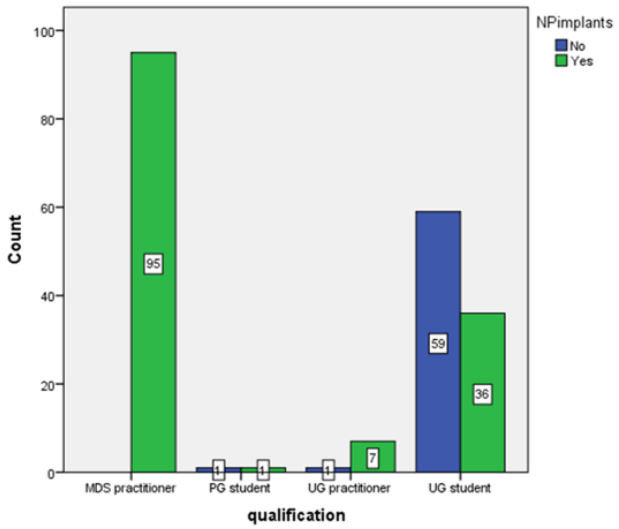

Figure 4: Correlation graph between the qualification and the awareness about the use of nanoparticles coated implants was done using Chi-square test

Nanoparticles are intentionally embedded into products to improve their material properties. Considering the important success in clinical and in vivo cases, the nanoparticle based implant coatings will act as a successful source in dental labs. Coating

the nanoparticles on dental implants improves its osteoconductive property (Wennerberg, 2011).

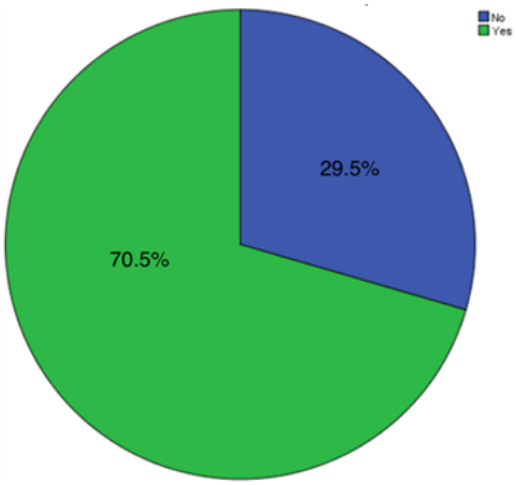

Figure 5: Pie chart representing the awareness about the antimicrobial properties of the nanoparticles

Thus able to induce a chemical bond with the bone to gain an ideal biological fixation, by increasing the number of osteoblast density making it a more stable implant (Abdulkareem, 2015). Lower incidence of mechanical failure and higher marginal accuracy were found in the original abutments (Duraisamy, 2019).

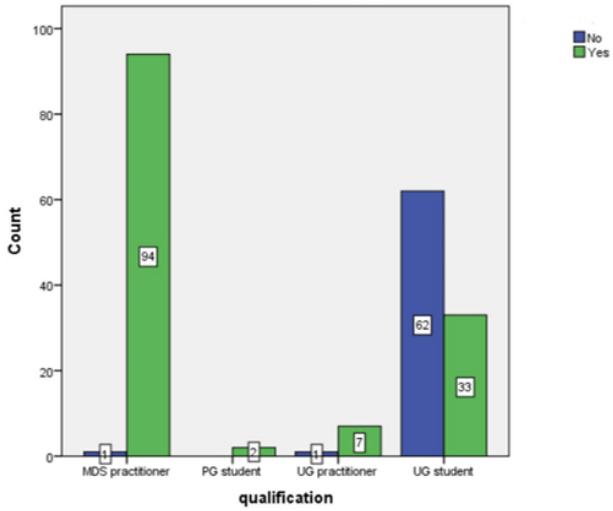

Figure 6: Correlation graph between the qualification and use of antimicrobial properties of implant coated with nanoparticles was done using Chi-square test

They also exhibit antibiofilm activity along with other healing properties (Ferraris, 2014). Thus, these coating materials are used to control and improve implant success rate by primarily focusing on enhanced osseointegration and antimicrobial property. Nanoparticles coated implant materials that are more effective than conventional materials. Enhanced osseointegration induces chemical bonds with bone to attain good biological fixation for implants (Vogel, 2015). Surface modifications of implants decrease the potential for infections by enhancing its antimicrobial properties. Thus the use of implants coated with nanoparticles has more effective effects compared to the conventional materials. This article provides us with the insight about the awareness, uses and applications of implants coated with nanoparticles with antimicrobial properties.

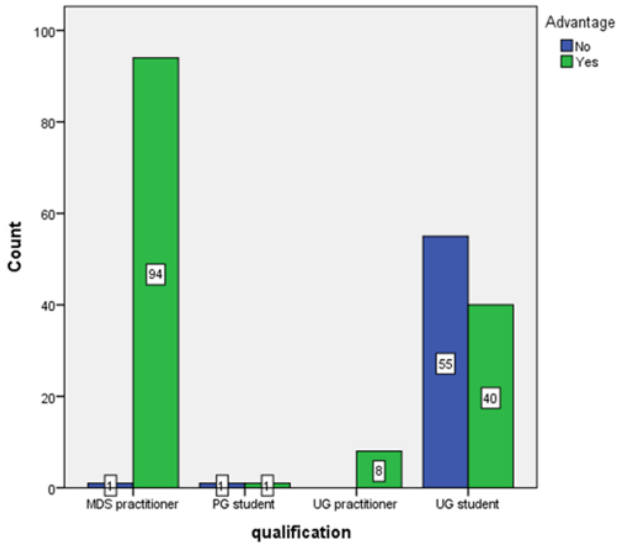

Figure 7: Correlation graph between the qualification of the participants and their perspectives on the use of nanoparticles over conventional biomaterials was done using Chi-square test

MATERIALS AND METHODS

This survey consisted of 200 participants, and the structured questionnaire was circulated through online access. This was recognized by the research ethics of Saveetha Dental College and Hospital. A set of 15 questions about the basic idea, knowledge and awareness about the implant coated with nanoparticles was prepared and circulated among the UG students, PG students, use the practitioner and MDS practitioner. Using this questionnaire, participants were asked about the degree of awareness about the use of nanoparticles coated implants and about the use of it in their practice (Ashok and Suvitha, 2016). This survey described their degree of awareness, concern, and expectations about implants coated with nanoparticles and their need for information and education about the subject. To assess the differences, the obtained results were plotted graphically. Frequencies were determined for each cate-

gory and analyzed.

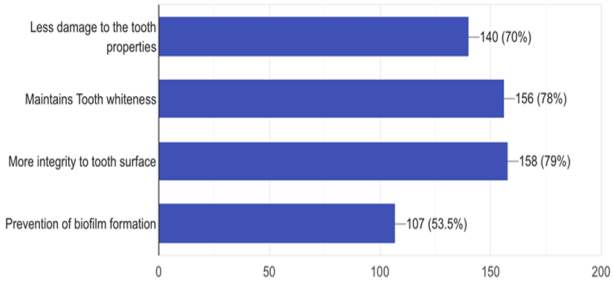

Figure 8: Bar chart listing the advantages of nanoparticles when compared to the conventional biomaterials

RESULTS AND DISCUSSION

Dental implantology is an important speciality in the field of dentistry. Dental implants paved the way for the replacement of missing teeth with much easier, comfortable, stable, aesthetically good and natural-looking artificial replacements. Use of nanoparticles in the dental field is known as nano dentistry. This is an advanced technology in maintaining our oral health though there are several natural sources available (Subasree *et al.*, 2016). Use of implants and partial dentures can cause periodontitis (Jyothi, 2017).

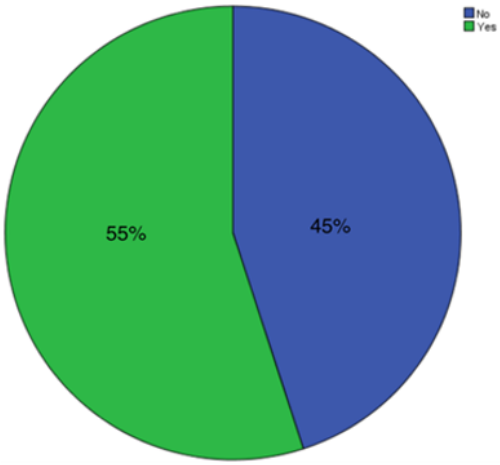

Figure 9: Pie chart representing the preference of nanoparticle coated implants in dental practice among the participants

It also promotes microbial growth (Selvan and Ganapathy, 2016). Other complications are also associated with the use of implants (Vijayalakshmi and Ganapathy, 2016). While choosing the nanoparticle for the use in the field of nano dentistry, it is essential to take into account its chemical, physical, along with the biological aspects. Previously we have worked on various subjects regarding the discrepancies in using artificial abutments (Ashok, 2014). Nanomaterials are suitable candidates for coating on dental implants due to their unique properties (Ajay, 2017). The objective of this article is to the successful application of the nanoparticles coated implants in the clinic. The results obtained through the survey were graphically represented. This dealt with the basic preferences and perspectives of the dentist about the subject.

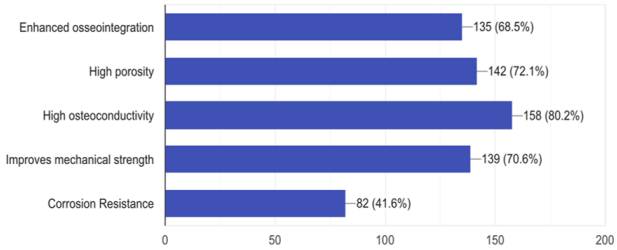

Figure 10: Bar chart representing the advantages of using nanoparticle coated implants over conventional implants

This survey was held among dental students and practitioners, of which 47.5% were UG students, 1% were PG students, 4% were UG practitioners, and about 47.5% were MDS practitioners Figure 1. There were significant differences in their preferences based on their qualification. It was found that a vast majority of the participants were familiar with the term nano dentistry, yet only some of them had detailed knowledge.

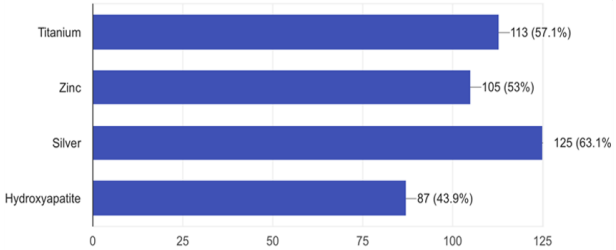

Figure 11: Bar chart representing the type of nanoparticles preferred in their practice

Only 2.5% were unaware of the term, while 97.5% were aware of it Figure 2. Most of them gained knowledge from books and the internet. Some were aware of the nano-sized advanced clinical tools used for maintenance of comprehensive oral health and development of novel medicines. This study revealed that there is awareness of the word Nanodentistry. Figure 3represents the aspects of dentistry that use nanoparticles. This includes diagnosis, prevention and treatment of oral diseases. Of 200 participants, 72% were aware of the use of nanoparticles for polishing the enamel surface; this makes the Matrix smoother and decreases the roughness, this can be observed in nano filled and mono hybrid residents. 74% were aware of the anti-

sensitivity activity due to which it is often incorporated in the toothpaste to provide a rapid relief along with its fluoride releasing property. 81.5 % were aware of the teeth whitening property. It is coated over the tooth surface and is irradiated by blue light. This gave a similar effect like hydrogen peroxide-based agents.

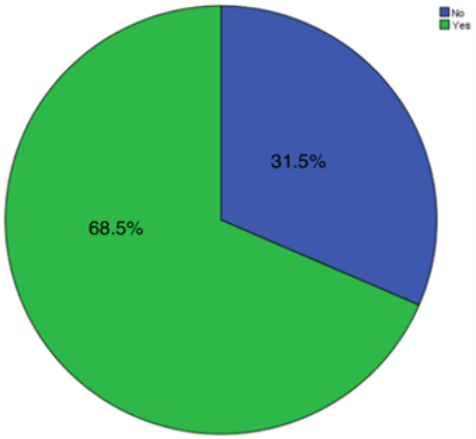

Figure 12: Pie chart representing the knowledge about the toxicity caused by the nanoparticles

Over 75.5% knew its use in dental implants. 89% of them were aware of its use in cavity filling property due to its antibacterial action and regeneration capacity (Xavier, 2015). 69.5% of the respondents were aware of the nanoparticles coated implants, and 30.5% had no knowledge about it Figure 4. Thus helps in improving the maintenance of our oral hygiene (Basha *et al.*, 2018). Knowledge is usually necessary to make intelligent decisions upon which to act. The knowledge about the use of nanoparticles can pave the way for its use in better clinical applications. One must be aware of the recent advances and successful dental techniques developed in dentistry.

According to Figure 5, 69.5% knew the use of nanoparticles coated implants with the antimicrobial property. 35 5% were unaware. 68% had awareness about the antimicrobial property of implants coated with nanoparticles, and 32% were unaware Figure 6. Using an implant coated with nanoparticles with antimicrobial properties can have a multi functional effect (Roy *et al.*, 2013). Figure 7 showed that 71.5% knew the advantages of nanoparticles over conventional biomaterials. 28.5% had the least knowledge about the nanoparticles and its advantages. The main advantage of nanoparticles is their small size.Thus it has a large surface to volume ratio when compared to peptides and small proteins. They can easily diffuse across membranes and facilitate uptake by cells by increasing the surface-to-volume ratio. Nanoparticles have been used in different biomedical applications such as targeted drug delivery, hyperthermia, photoablation therapy, bioimaging, increased durability and biosensors. In this survey out of 200 participants, 79% were aware of the improved integrity of the nanoparticles to the tooth surface, 78% were aware of the tooth whiteness maintained by the nanoparticles compared to the traditional biomaterials. Other properties include less damage to the tooth properties (70%) and prevention of biofilm formation ability (53.5%) (Areid *et al.*, 2018)Figure 8. 55% of the clinicians preferred to use nanoparticles coated implants in their practice. 45% have not used it in their practice Figure 9.

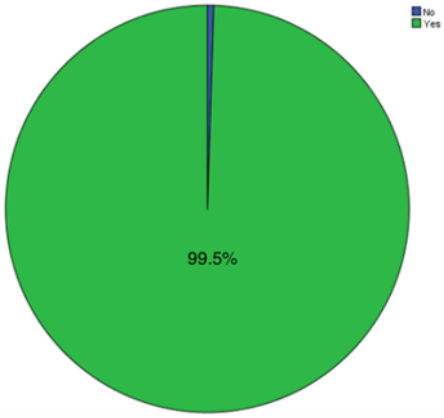

Figure 13: Pie chart representing the usefulness of the survey

Advantages of nanoparticles coated implants are depicted in Figure 10. 68.5% said it had enhanced osseointegration property, 80.2% believed it had increased porosity due to its highest integration to the tissues, and 80.2% had knowledge about its high osteoconductive property compared to the conventional implants. Nanomaterials also have the property of reducing microleakage (Ganapathy, 2016). Improved mechanical strength compared to conventional implants was observed by 72.6% of the practitioners Due to its reinforcement and increased time stability. 82% Where are aware of its corrosion-resistant to the property by preventing environmental oxidation. Several materials were identified as possible candidates for dental implant coatings; these include carbon, bisphosphonates, bone stimulating factors, bioactive glass and bioactive ceramics, fluoride, hydroxyapatite (HA) and calcium phosphate, and titanium/titanium nitride. 63.1% Of the respondents were mostly aware of silver nanoparticles incorporated in implants. 57.1% were aware of using titanium, 53% were aware of using zinc, and 43.9% were aware of using hydroxyapatite Figure 11. The most preferred nanoparticle was silver due to its cell compatibility and enhanced

cell attachment. The hydroxyapatite shows anti-biofilm activity and is also one of the most preferred nanoparticles. Possible antimicrobial activity and immunomodulatory effect of nano-ZnO films were also investigated.

Figure 12 showed that High percentage (68.5%) of the participants knew the dangers of nanoparticles in dentistry for human health and the environment. Silicone elastomers also provide more options to clinicians for customization of the prosthesis (Venugopalan, 2014). The disadvantages of the use of nanotechnology in dentistry are the high costs of the products and sometimes its screw loosening property (Ganapathy *et al.*, 2017). Considering that the era of antibiotics to control infectious biofilms will eventually come to an end, the future for biofilm control on implants and devices is likely with surface-associated modifications like nanoparticles embedded implants (Swartjes, 2015). They should have sufficient knowledge about the toxicity of such formulations. One hardly comes across the concepts on nanotechnology or nano dentistry cost-effective curriculum of dental education. A need was felt to carry out a survey to measure knowledge, and attitude application of nanoparticles coated dental implants in the field of dentistry. Most of them found the survey useful Figure 13. The rationale of this survey research was to evaluate the knowledge and awareness about the subject.

CONCLUSION

Nanoparticles are going to be an essential part of clinical dental practice. Different nano strategies cope up to address dental problems. Nano dentistry attracts patients towards dentistry since it will be cost-effective, timesaving and prevent patients from mental trauma. Development of modified nanomaterials is surely going to help in solving dental problems. Many were unaware of the advantages of nanoparticle coated implants over traditional implants. The high percentage of the participants didn't have an opinion about the dangers of nanoparticles for human health and the environment. Most participants wanted to get more information about the application of implant coated nanoparticles with antimicrobial properties. Therefore it is important to create awareness about the use of the implant coated with nanoparticles with antimicrobial properties among the dental practitioners.

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Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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