

Awareness Of Nanotechnology Used In Dentistry Among Dental Practitioners And Students In Tamil Nadu, India- A Survey

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ABSTRACT

Background

Nanotechnology is a fast-emerging technology, with its influence felt in every realm of the scientific intelligentsia, including the medical and dental field. As the scientific community progresses at an exponential rate, it is imperative that the dental practitioner becomes familiar with these advances, as what is norm today becomes obsolete tomorrow.

AIM

The aim of this study was to assess the knowledge and awareness of nanotechnology in dentistry among post graduate students and practitioners.

METHODS

This cross-sectional study was conducted among practitioners and post graduate students in Tamil Nadu. A self-administered questionnaire was circulated electronically among them. The questionnaire assessed demographic data and knowledge regarding general nanotechnology and nanotechnology use in dentistry. The responses to the questionnaire were subjected to data analysis.

RESULTS

Post graduate students showed most awareness and knowledge about nanotechnology, with least being among general practitioners. Majority of the respondents got information about nanoparticles from Journals, followed by information obtained from attending lectures and seminars. A great percentage of respondents agreed that nanoparticles could improve properties of dental materials and strongly agree that it will have wide applications in dentistry.

CONCLUSIONS

There exists a lacuna in knowledge and awareness of nanotechnology applications in dentistry among general practitioners. This study indicates that there should be more CDE programs and seminars on nanotechnological advancements and should also be incorporated into the dentistry curriculum to increase the knowledge, attitude, and practice of nanotechnology in dentistry.

Key Words: Nanotechnology, Nanoparticles, Dentistry, Awareness

INTRODUCTION

In 1959, at the annual meeting of the American Physical Society, physicist and Nobel laureate Richard P. Feynman while delivering the landmark lecture on atomic scale technology and engineering entitled “There is plenty of room at the bottom”¹ stated that, the manipulation of atoms and molecules would contribute to the development of many new inventions, and he concluded his lecture saying “This is a development which I think cannot be avoided”, thus, marking the dawn of nanotechnology². Feynman is considered the father of modern nanotechnology².

Science is currently in the nanotechnology epoch, and a variety of nanotechnologies are being used in industrial, defense, consumer, and biomedical applications. The term “nano” is a prefix that originated from a Greek word meaning “dwarf”, one nanometer (nm) equals 10^{-9} m, and atoms are ~ 0.1 nm.^{3,4} In the medical field, nanotechnology is used in the development of drug delivery systems that specifically target cancer cells in the body without damaging healthy cells. R.A. Freitas Jr. first used the term nanodentistry in the year 2000, when discussing the future of dentistry to be consisting of nanodentistry, tissue engineering, and dental nanorobots.⁵ Owing to the rising need of improving the properties of conventional dental materials like restorative cements and composite materials, keeping the quality of dental materials as a non-negotiable factor, nanotechnology has led to the development of better and more durable restorative materials for improved dental care. As nanoparticles are < 100 nm in size, the surface area per gram of powder is very high, thus the

incorporation of nanoparticles into composite materials will likely change the properties of the materials, including improving the aesthetic and mechanical properties.⁶

The goal of nanotechnology in dentistry with regards to oral health is to prevent, rather than to treat oral diseases, particularly dental caries, and periodontal diseases. For example, nanoparticles such as calcium carbonate, have good retention on oral surfaces and allow for slow continuous release of high concentrations of calcium ions into the surrounding oral fluids⁷. These calcium carbonate nanoparticles can also increase the pH of the surrounding fluid, thereby remineralising any incipient lesions. In addition, nanoparticles of calcium fluoride have been shown to be highly soluble and reactive, thereby increasing the fluoride concentration in oral fluids and enhancing tooth remineralization.^{8,9,10} Hydroxyapatite, is a non-active calcium phosphate and structural component in enamel, dentin, and bone.¹¹

Added to this, an upcoming new modality of nanotechnology is the eco-friendly biologic method of generating nanoparticles, which uses organic medium to synthesize nanoparticles in a controlled manner.^{12,13,14,15}

Nanotechnology has been introduced in dentistry either as an additive and enhancements to already existing dental materials or as a new therapeutic modality or concept for solving oral health issues. The aim of this research survey is to evaluate knowledge of and attitude towards nanotechnology in dentistry among postgraduate dental students and practitioners in Tamil Nadu.

METHODS

This was a cross-sectional survey in which online questionnaires were distributed to post graduate dental students and dental practitioners- both

general practitioners and specialists, residing in Tamil Nadu and was carried out during May 2021 to July 2021. Inclusion criteria included any specialty post graduate students and practitioners, both general and specialist. The questionnaire was circulated to a total of 204 students and practitioners selected by random sampling. The questions were simple and concise multiple-choice questions that addressed knowledge and attitude toward nanotechnology in dentistry. The questions were subdivided into five categories: 1)

demographic data, 2) attitude toward nanotechnology, 3) assessment of general nanotechnology knowledge, 4) assessment of knowledge regarding the application of nanotechnology in dentistry, and 5) assessment of knowledge regarding the future of nanotechnology. The first page of the online questionnaire explained the purpose of the research and assured the confidentiality of the collected data.

RESULTS

The responses were collected and was subjected to descriptive data analysis and represented by means of bar chart and pie chart. Of the total participants, 56.7% were post graduate students (Figure 1). Most of the participants were female (72.1%). Regarding knowledge of nanotechnology, 30.3% of participants were not familiar with nanotechnology, whereas 24.3% of students and specialists had heard of nanotechnology from an instructor in class or from attending seminars. 46.2% of participants responded that nanotechnology referred to <100 nm, 37.2% of participants responded that nanotechnology referred to <100 μm , and 12.4% responded that nanotechnology referred to <100 μL . Only 46% of total participants were aware of eco-friendly alternate methods of manufacturing nanotechnology.

Regarding knowledge of the application of nanotechnology in dentistry (Figure 2), most of the postgraduate dental students (84.9%) were

aware of nanoparticle incorporated toothpastes, bonding systems and mouthwashes, whereas only 12.7% of general dental practitioners were aware about it. 32% of specialists were aware about nanoparticle incorporated impression materials as opposed to 60% of the post graduate students. 65% of participants (post graduate students) were aware about the new technological concept of nanobots for analgesia, followed by specialists who make up 27% of the total who were aware about this concept.

Regarding the future of nanotechnology, 61% of dental students believed that nanotechnology could benefit human and environmental life, whereas 33.9% believed that nanotechnology can have both beneficial and harmful effects due to extensive exposure to the nanoparticles. The majority (91.6%) of participants believed that nanotechnology in dentistry will improve treatment quality in the future, whereas only 7.2% of them believed that nanotechnology will not affect treatment quality.

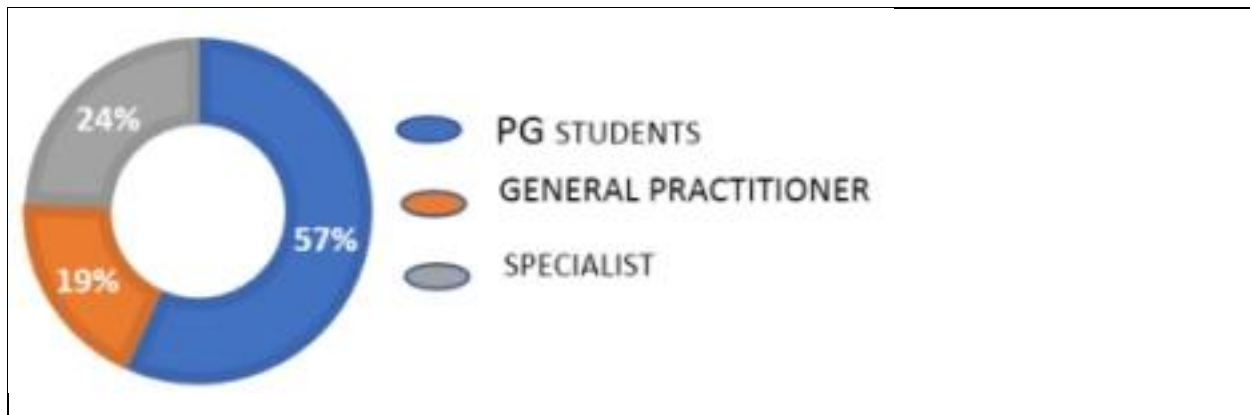
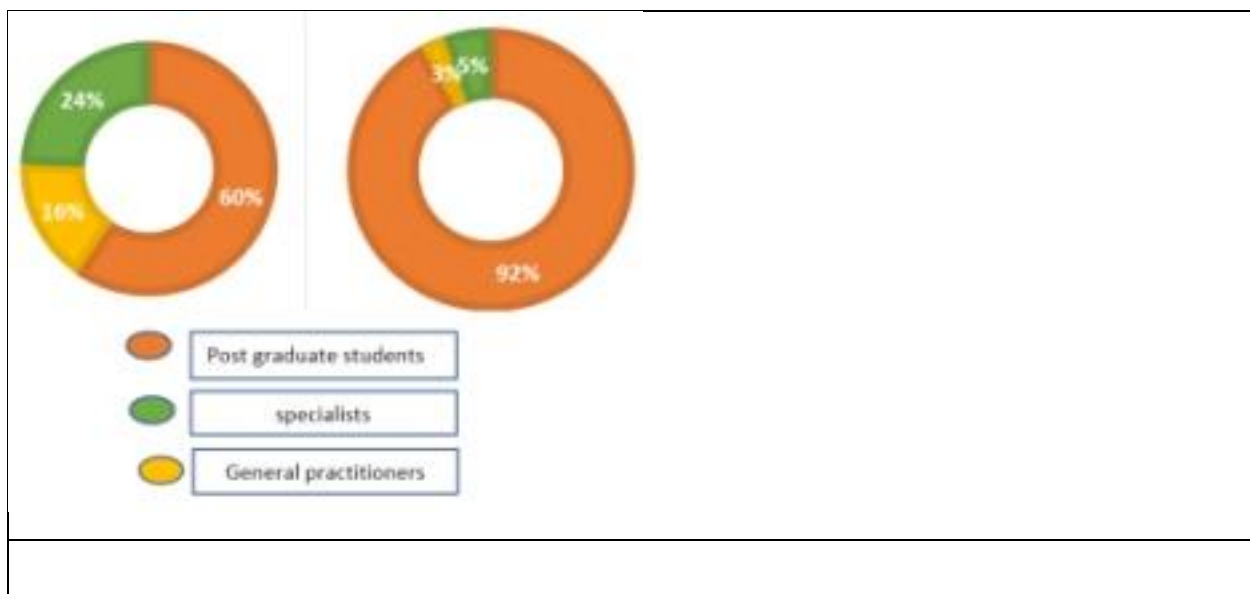


Figure1. Designation



TOOTH PASTE

BONDING SYSTEMS

IMPRESSION MATERIALS

JAWBOTS ANALGESICS

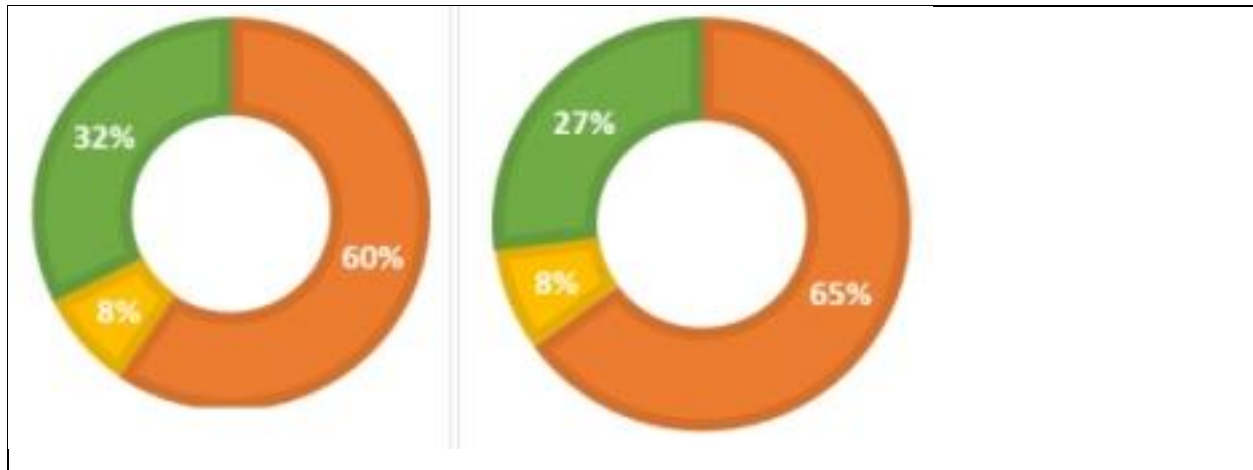


Figure 2. Knowledge of Nanotechnology

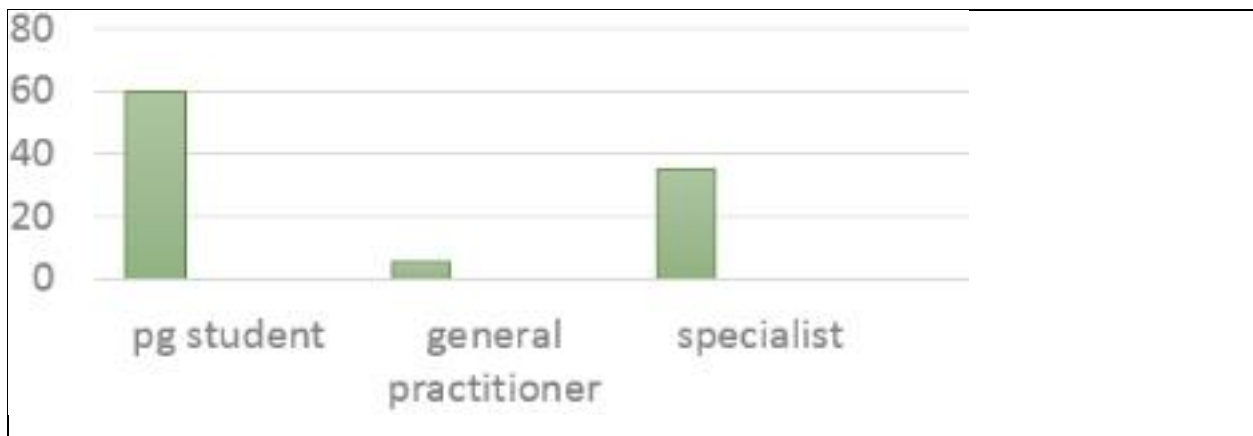


Figure 3. Designation Based Awareness

DISCUSSION

Nanotechnology has been gaining attraction from researchers in every field of science; from improving the physical and mechanical properties of dental materials, providing solutions for antibiotic resistance to managing oil spills in oceans. This survey focused on the advances in dentistry owing to nanotechnology and the understanding among postgraduate dental students and practitioners about it and to identify the lacunae of information regarding nanotechnology.

Of the participants, 62% postgraduate students were aware and had knowledge about nanotechnology, and these results are similar to the results in a study by Sakr et al. in which 69.3% of participants had heard of nanotechnology¹⁶. However, Ali et al. study showed that only 50.8% of their students knew about nanotechnology.¹⁷

However, most of the students (88.4%) and practitioners (92%) recommended inclusion of a nanotechnology lecture in the academic curriculum and CDE programs indicating that students are willing to learn about the benefits of new technologies such as nano dentistry and

update themselves after finishing training programme from college.

Nanotechnology has been incorporated as a university major in developed countries, including the UK and the USA.¹⁸ Based on questions regarding general nanotechnology knowledge, 46.2% of participants thought that nanoparticles are < 100 nm. In fact, particles with dimensions from 1–100 nm allow for complete control of matter.¹⁹

Although nanotechnology is currently considered to be expensive, it is expected to be cost effective and more efficient in the future²⁰. Regarding knowledge of the application of nanotechnology in dentistry, 84.4% of participants thought that the use of nano titanium implants can increase the quality and success rates of implants, however Ali et al. showed that 95% of students never used nano implants in their clinicals²¹. It has been shown that the use of nanotechnology in implants accelerates and increases bone-implant integration.²¹ Of the participants, 62.5% thought that the application of nanotechnology in dentistry will be supplemental. Currently, nanotechnology plays a supplemental role in dentistry, but in the future,

nanotechnology could change health care in fundamental ways.²²

Regarding the future of nanotechnology in dentistry, 33.9% thought that nanotechnology can affect human and environmental life in both beneficial and harmful ways due to extensive exposure to nanoparticles.

Concerns regarding the health and environmental risks caused by extensive exposure to nanoparticles led to the emergence of the nanotoxicology and nanomedicine disciplines.⁴ Nanotoxicology is the study of potential adverse health effects caused by nanoparticles, and this field has developed due to the limited, reliable toxicity data for nanoparticles.⁶ In addition, 91.6% of students thought that nanotechnology will improve the quality of treatment in dentistry. Currently, nanotechnology affects human life daily and has become the foundation for important industrial applications and is expected to change health care in fundamental ways.¹⁹ Our survey showed that there exists a wide gap in knowledge about nanotechnological advances among practitioners. (Figure 3).

CONCLUSIONS

This study showed a lack of awareness of nanotechnology use in dentistry among general dental practitioners. However, this could have been influenced by the greater response from post graduate students. Although one must be careful while generalizing the results of this study, it does not seem unreasonable to assume that dentists in other regions would have responded similarly. None the less, this study indicates that nanotechnology should be incorporated into the dentistry curriculum and as continuing dental education programme to increase the awareness of nanotechnology in dentistry.

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