



## **Awareness of Nanomedicine among Undergraduate Dental Students**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Author PD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors KKP and AV managed the analyses of the study. Author DG managed the literature searches. All authors read and approved the final manuscript.*

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### **ABSTRACT**

The term Nanotechnology involves a spectrum of technologies, techniques and processes that can deal with a matter at the nanoscale falling in between 1 nanometre to 100 nanometres in size. The concept of nanotechnology was introduced in 1959 by Richard P Feynman, a Nobel winning physicist. The aim of this research is to assess the knowledge and awareness of nanomedicine and its application in the field of dentistry among dental students. A cross-sectional study was conducted among 100 dental undergraduate internship students. The questionnaire contained 10 open-ended questions eliciting the knowledge and awareness about nanomedicine and its application in dentistry. The questionnaire was distributed via an online survey tool. The responses were collected and tabulated in the excel sheets, following which they were exported to SPSS software for statistical analysis. 52% of the students were aware of the term nanomedicine. 33% and 16% of the students had awareness of the nano modified impression material and nano modified denture teeth respectively. This study concluded that the knowledge and awareness of nanomedicine and its application in the field of dentistry was moderate among dental students.

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## 1. INTRODUCTION

The dawn of the atomic age commenced when Dr. Richard Feynman, coined the term Nanotechnology, in 1959. Nanotechnology commonly known as Nanotech is the manipulation of the atoms in the atomic, molecular and supramolecular levels [1]. Nanomedicine is a branch of medicine that applies the knowledge and tools of nanotechnology to the prevention and treatment of disease. Nanomedicine involves the use of nanoscale materials, such as biocompatible nanoparticles and nanorobots, for diagnosis, drug delivery, treatment and in finding new preventive measures for existing diseases and conditions [2].

Many products have been developed with nanotechnology applications, including technological devices, pharmaceutical products, building materials and in the field of medicine. The European Science Foundation (ESF) defined nanomedicine as “the science and technology of diagnosing, treating, preventing disease and traumatic injury, of relieving pain, of preserving and improving human health, using molecular tools and molecular knowledge of the human body [3]. The knowledge of the risks of nanoparticles and how society would regulate it as necessary for the development day back to centuries ago.

Nanotechnology has its applications from the military to its application as Nanomedicine in the fields of dentistry and medicine. Real-time applications include more efficient drug delivery systems and diagnosis and treatment of diseases. In the field of medicine, the possibilities in electronics stem from the prospect of even smaller and smarter electrical devices [4]. All of these potential applications have the power to significantly affect our lives or health, or convenience, and the environment; therefore, they tend to trigger major concerns from universities.

The greatest challenge for nanotechnology is students' lack of understanding. The concern does not originate in the science but in the students' scepticism of projected applications [5]. Nanomedicine has tremendous applications in the diagnosis and treatment of several oral diseases and the development of newer biomaterials for restorative and prosthetic

treatments. Hence it is very vital for the dental students to be aware of these developments. Previously our department has published extensive research on various aspects of prosthetic dentistry [6–16], this vast research experience has inspired us to research about the awareness of nanomedicine among undergraduate dental students. The aim of this study is to assess the knowledge and awareness of dental students about the applications of nanomedicine in the field of dentistry.

## 2. MATERIALS AND METHODS

This was a cross-sectional questionnaire based study that assessed the awareness of nanomedicine and its dental applications among dental undergraduate students.

### 2.1 Sampling

The entire population of 100 dental undergraduate internship students were involved in the study. There were no chances of sampling bias as the entire sample was involved. Good external validity for the present study, as the full population cluster was involved and the results obtained can be generalisable within the state and country in which the students have obtained similar training.

### 2.2 Data Collection

The data collection was done via Google forms. The questionnaire contained questions about the awareness and knowledge of nanomedicine in dentistry. The content validity was assessed by average congruency percentage and Cronbach's alpha was used to assess the reliability of the questionnaire. Google forms were used to circulate the questionnaire among the students. The data obtained was collected and tabulated using excel sheets the data was transferred to SPSS software by IBM for statistical analysis.

### 2.3 Statistics

The data was transferred to SPSS software by IBM, version 25 for Windows OS. In which the output variables were defined. The results were expressed as percentages.

## 3. RESULTS AND DISCUSSION

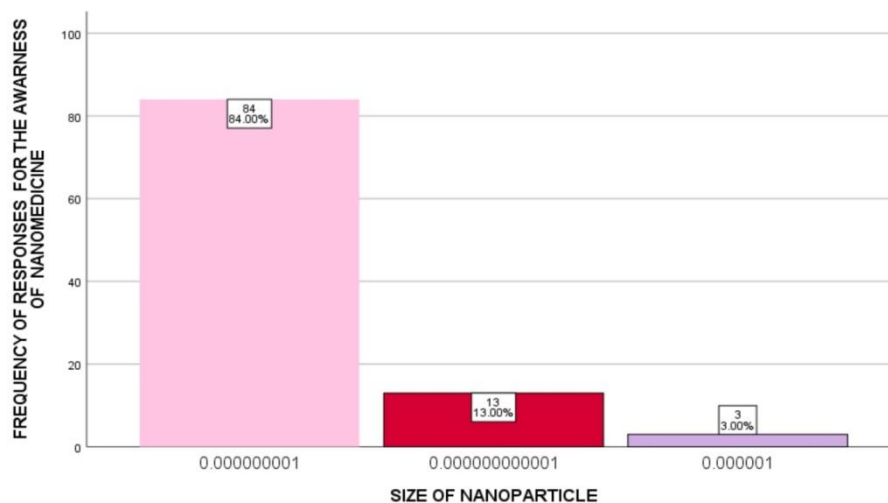
84% of the students answered correctly that the size of the nanoparticle is  $10^{-9}$ . (Graph 1). 52% of

the students were aware of the term nanomedicine, while 48% were not aware of the term nanomedicine. (Graph 2). 41% were aware of local nano anaesthesia, while a majority of 59% of the students were not aware of it. (Graph 3). Only 29% were aware of the nanobots, while a majority of 71% were not aware of the dentin hypersensitivity nanobots used to treat dentin hypersensitivity. (Graph 4). 24% of the study population were aware of the dentifrobots, and 76% of the students were not aware of the dentifrobots. (Graph 5). 83% were aware of the nano-drug delivery systems, while 17% were not aware of the nano-drug delivery. (Graph 6). 95% were aware of the nanocomposites and 5% were not aware of the nanocomposites (Graph 7). 33% of the students had awareness of the nano modified impression material while 67% of the students lacked awareness (Graph 8). 16% were aware of the nano modified denture teeth, while 64% of the students lacked awareness. (Graph 9). 83% had awareness of the applications of the nanomedicine in the diagnosis and management of oral cancer, while 17% lacked awareness. (Graph 10).

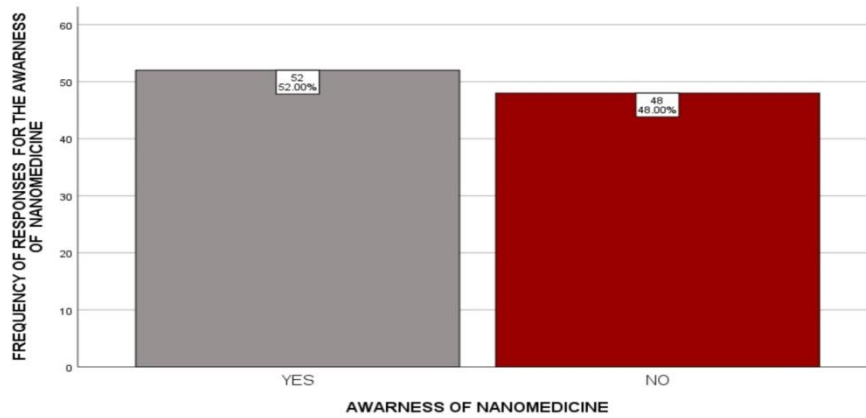
Nanotechnology is a science that deals with physical and biochemical properties of materials and its constitutions at nanoscale dimensions. 52% of the students were aware of the term nanomedicine, while 48% were not aware of the term nanomedicine [17]. 41% of the students were aware of local nano anaesthesia , while a

majority of 59% of the students were not aware of it . A future nanotechnology-based local anesthetic suspension will consist of micron size millions of active analgesic ambulating dental robots suspended in a colloidal suspension. These hi-tech anaesthetic suspensions when in contact with tooth surface or gingiva will reach the pulp resulting in temporary and reversible shut down of all the sensitivity or pain in the tooth specific to the area of interest that requires the treatment [18].

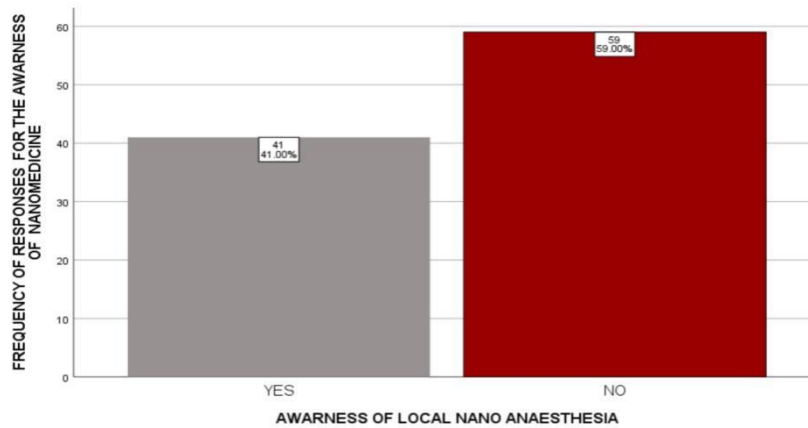
Nanotechnology-based anesthetic suspensions will exhibit a remarkable property of being able to be remotely controlled by a dentist by an on-board computer which can be restored or reversed at any moment when the procedure is finished [19]. Only 29% were aware of the nanobots while a majority of 71% were not aware of the dentin hypersensitivity nanobots used to treat dentin hypersensitivity. Dentin hypersensitivity results from a fluid dynamics-based phenomenon where the pressure is transmitted hydrodynamically to the underlying nerves in pulp resulting in the generation of the stimulus. Hypersensitive teeth exhibit eight times increased response of dentinal tubules as compared to non-sensitive teeth [20]. Nanorobots can help in overcoming the dentinal hypersensitivity by occluding these dentinal tubules in a more target-specific and precise approach, thus relieving patients suffering by providing a long-lasting cure [21].



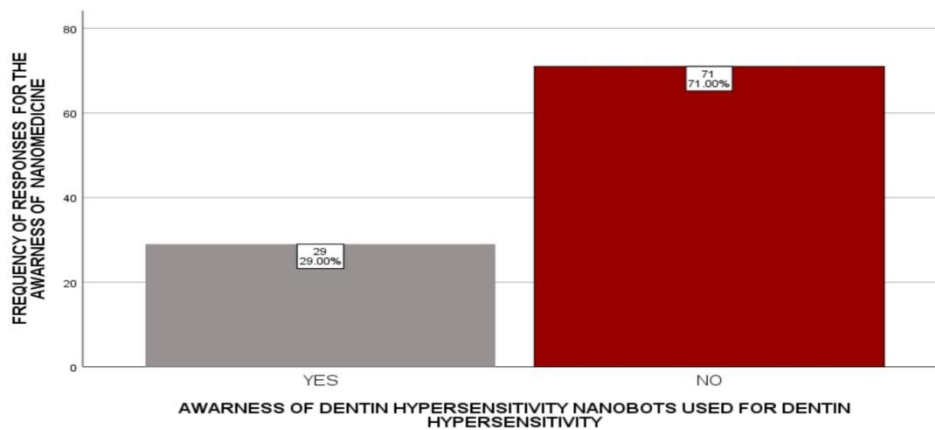
**Graph 1.** This bar chart represents the responses to the size of the nanoparticle, 84% of the students answered correctly that the size of the nanoparticle is  $10^{-9}$  (pink colour), while 13% and 3% answered incorrectly that the size of the nanoparticle was  $10^{-12}$  and  $10^{-6}$



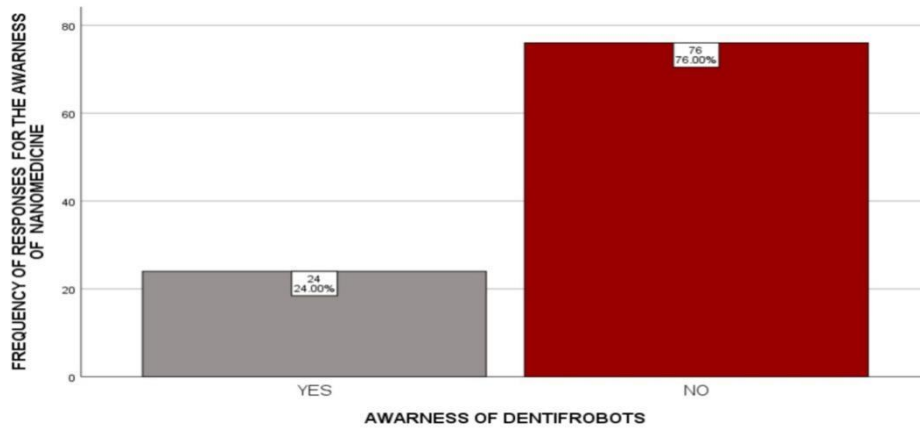
**Graph 2.** This bar graph represents the awareness of the term nanomedicine among students 52% of the students were aware of the term nanomedicine (grey colour), while 48% were not aware of the term nanomedicine (red colour)



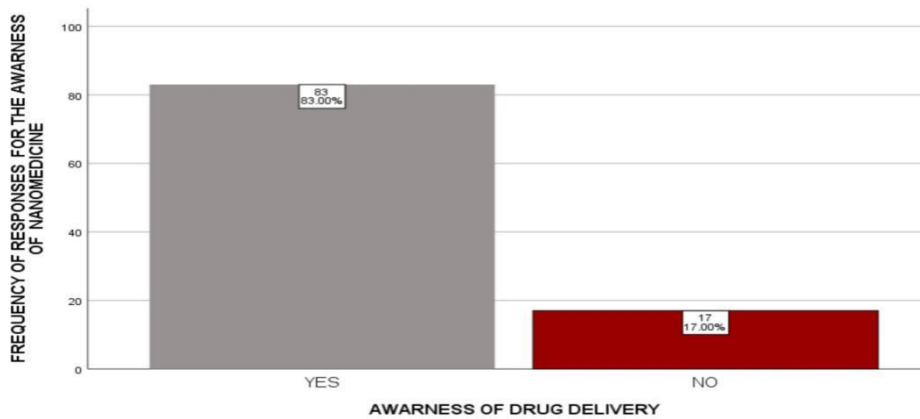
**Graph 3.** This graph represents the awareness of local nano anaesthesia among the students. 41% were aware of local nano anaesthesia (grey colour), while a majority of 59% of the students were not aware of it (red colour)



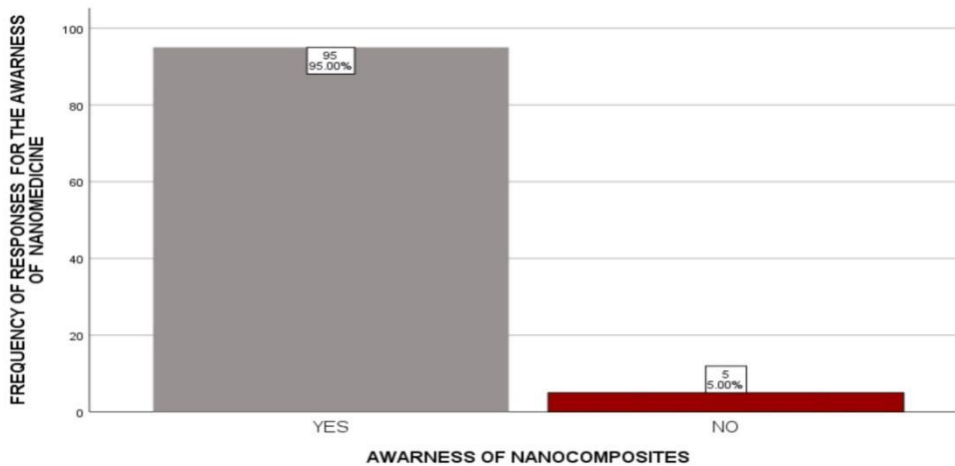
**Graph 4.** This bar chart represents the awareness of nanobots used for dentin hypersensitivity, among the study population. Only 29% were aware of the nanobots (grey colour) while a majority of 71% were not aware of the dentin hypersensitivity nanobots used to treat dentin hypersensitivity. (Red colour)



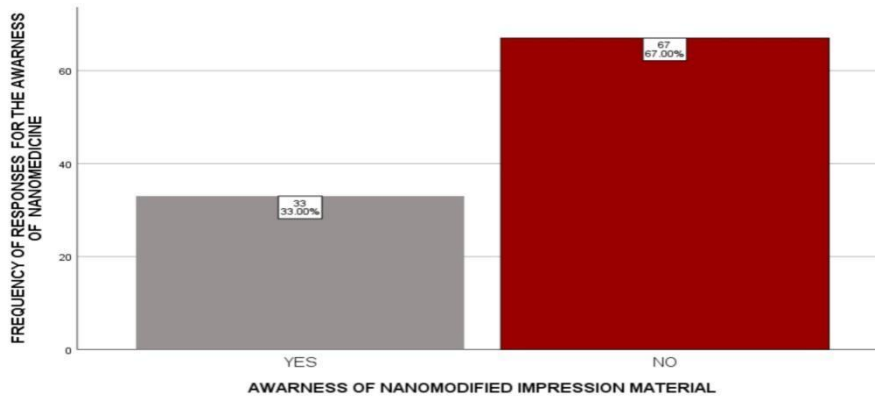
**Graph 5.** This graph depicts the awareness of dentifrobots among the study population. 24% of the study population were aware of the dentifrobots (grey colour), and 76% of the students were not aware of the dentifrobots (red colour)



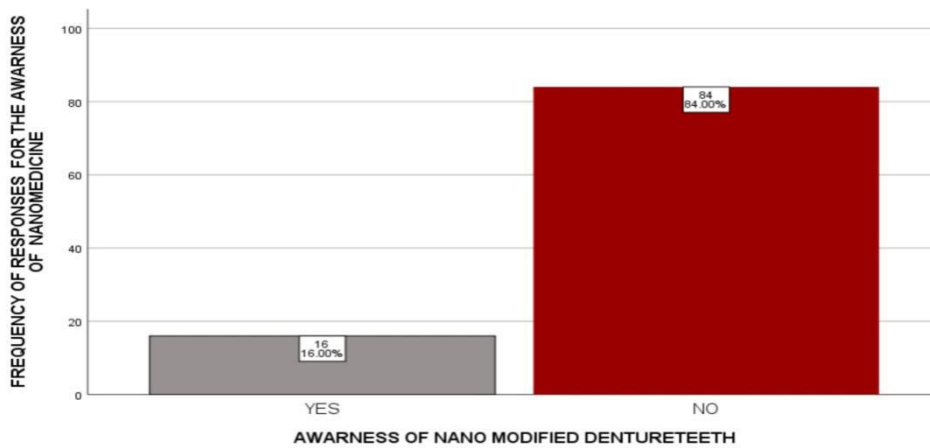
**Graph 6.** This graph shows the awareness of nano drug delivery among the study population. 83% were aware of the nano drug delivery systems (grey colour), while 17% were not aware of the nano drug delivery (red colour)



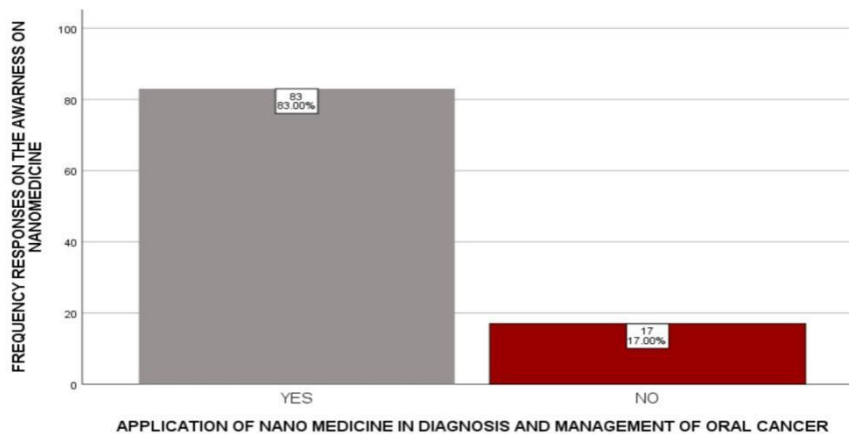
**Graph 7.** This graph depicts the awareness of nanocomposites among the students. 95% were aware of the nanocomposites (grey colour) and 5% were not aware of the nanocomposites (red colour)



**Graph 8.** This simple bar chart depicts the awareness of nanomodified impression material among the students. 33% of the students had awareness on the nano modified impression material (grey colour), while 67% of the students lacked awareness (red colour)



**Graph 9.** This bar graph depicts the awareness of nano modified denture teeth among the study population. 16% were aware of the nano modified denture teeth (grey colour), while 84% of the students lacked awareness (red colour)



**Graph 10.** This graph depicts the awareness of the application of nanomedicine in the diagnosis and management of oral cancer. 83% had awareness of the applications of the nanomedicine in the diagnosis and management of oral cancer (grey colour), while 17% lacked awareness (red colour)

24% of the study population were aware of the dentifrobots, and 76% of the students were not aware of the dentifrobots. Dentifrobots are nanobots that can be used in toothpaste form which can remove the subgingival plaque and calculus and prevent its accumulation and thereby decreasing the chances of gingival and periodontal diseases [22]. 83% were aware of the nano drug delivery systems, while 17% were not aware of the nano drug delivery. Nanorobots can also be used in the field of oral surgery and in drug delivery by making fine needles and injections which are corrosion resistant and can easily assess minute spaces [23]. 83% had awareness of the applications of the nanomedicine in the diagnosis and management of oral cancer, while 17% lacked awareness. Nanomedicine can also be used in the diagnosis and management of oral cancers. With the help of the Quantum Dots. These nanoparticles show a very bright luminance when viewed under ultraviolet light. The Quantum dots can be coated with a material showing affection to cancerous cells to be tracked and help to locate and detecting cancer cells by binding themselves to protein sequence unique to cancer cells, thus aiding in early detection, [24] And it can also be used along with brachytherapy to manage oral cancer. The new nano modified impression material has a longer working time and high compressive strength and the nano modified denture teeth are stronger than the conventional acrylic denture teeth [25].

According to the previous study among 80 students in Sri Lanka, 86% identified the correct size of the nanoparticle, 42% of the students were aware of the term nanomedicine. A majority of the students 27% learnt about nanomedicine from their university. 81% of the students lacked good knowledge of nanomedicine, 34% of the students supported that nanomedicine can be used in the diagnosis and management of diseases. The female students had a more positive attitude than Male students. [26] In the study done in 1413 medical residents, in Saudi Arabia, 63% of the students identified the correct size of the nanoparticle. Only 40.7% of the students had heard of nanomedicine. 81% lacked knowledge and awareness of Nanomedicine. [27]

In a previous study by Nassani et al, assessed the knowledge, attitude and perception of nanomedicine among medical residents, it was found that they lacked knowledge, but had a positive attitude and preferred to use nanomedicine in the medical field to treat

patients. [28] The results obtained by the previous studies were similar to the results obtained by the present study. There was a general lack of awareness and knowledge among the study populations of the present and previous studies.

The main limitations of the study are its limited sample size. Though all the students of the college when included in the study the sample size was limited. The study was confined to a single university and was restricted geographically. In the future, further studies, CME and CDE programs can be conducted on the applications of nanomedicine in the fields of medicine and dentistry. In the future, a multi-centered study in a pan India level can be conducted, by including the students of different universities within the country.

#### **4. CONCLUSION**

Within the limits of this study, it can be concluded that the students had moderate levels of awareness and knowledge of nanomedicine in the field of dentistry. While nanotechnology and nanomedicine have a lot of applications in the field of medicine dentistry and among other fields, they are not commonly used or they remain unknown, because nanotechnology though introduced in 1959 is slowly evolving, because it is expensive and there is a lot of scepticism surrounding it. One of the many ways to expose dental students about the innovations in this field is by conducting continuing education programs and seminars on the same.

#### **CONSENT**

As per international standard or university standard, Participants' written consent has been collected and preserved by the authors.

#### **ETHICAL APPROVAL**

The ethical board clearance was obtained from the Institutional Ethical Review Board of Saveetha Dental College and Hospitals.

#### **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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