

Potential of artificial intelligence in Dentistry: A cross-sectional survey among dental students of Southern India

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Abstract:

Background: Scientific discipline of artificial intelligence (AI) studies the computational understanding of intelligent behaviour as well as the development of artifacts that display this behaviour. Very limited information regarding artificial intelligence is included in the current syllabus of dental undergraduate students and hence, their perception about AI remains unclear.

Aim: was to determine the attitudes and perceptions on artificial intelligence in dentistry among undergraduate dental students in South India.

Materials and Methods: Four clusters based on geographic locations were formed from a list of southern colleges, with two schools selected from each via convenience sampling. A self-administered pre-validated 15-item questionnaire was mailed to 1174 undergraduate students to reach a sample size of 385. Data obtained was subjected to statistical analysis using SPSS v 25.0, IBM. Chi-square tests were used to study any association between the variables. A p-value of $p < 0.05$ was considered statistically significant.

Results: A total sample size of 385 was attained. 12.7% were males and 87.3% were female participants. The mean attitude and perception score was 57.3. There were significant differences in the year of study with mean scores pertaining to AI's diagnostic, treatment, prognosis and forensic dentistry applications ($p < 0.05$).

Conclusions: Majority of students strongly agreed that AI cannot replace dentists in future, but with mean scores significantly higher among final year students ($\bar{X} =$

4.36 Vs 4.05). Most of the students desired that AI applications be a part of undergraduate and postgraduate training ($\bar{X}$ = 4.14 and 4.2 respectively).

Keywords: Dental student, artificial intelligence, attitude, perception, dental education

Introduction:

Artificial intelligence is “the simulation of human intelligence processes by machines, especially computer systems”.^[1] Barr and Feigenbaum defined AI as “a part of computer science concerned with designing an intelligent computer system that exhibits characteristics we associate with intelligence in human behaviour—understanding language, learning, reasoning, and problem-solving”.^[2,3] The consequent rise in research inculcating artificial intelligence in dentistry has led to the consensus that AI will not only enhance reliability, reproducibility, accuracy and efficiency in dentistry but also increase our understanding of disease pathogenesis, improve risk-assessment-strategies, diagnosis, disease prediction and finally lead to better treatment outcomes.^[4-7]

AI can assist dentists with a range of jobs, from the most basic like recording a patient's medical history to that of more sophisticated ones.^[8-10] Significant success has been achieved in developing AI models for implant-type recognition, success prediction and design optimization and are continually evolving.^[11, 12] AI is taking over digital image analysis, growth simulation and prediction, 3D and 4D data segmentation, and even patient management and communication workflows are being fundamentally disrupted.^[11, 12] An additional factor will be the rapid adaptability of students in implementation of AI writing tools. This will necessitate

educators to reevaluate the instruction and student assessment considering AI technology, which can either be a powerful teaching assistant and a tool for creativity or can be misused by students.^[12]

The shift in AI paradigm has made it clear that the dentistry curricula need to be modified. It is imperative to consider the possible ethical ramifications of utilizing AI in dentistry, as well as the requirement that dental practitioners have adequate training in their application.

With all this said and done, dental students are taught based on syllabus which provides very little to minimal information about revolutionary concepts that are happening in the field of dentistry. To keep the young dentists aware of current scenario of dental sciences, it is very important to include the same in their curriculum so that all of them while graduating from a dental school have a good idea about the current topics. In a study conducted in Saudi Arabia, the medical and Dental Professionals' readiness for AI demonstrated a desire to learn but with low levels of AI expertise.^[13] According to a survey conducted in Turkey, 48% of dental students knew the basics of AI, and many of them thought it would revolutionize dentistry.^[8]

In a cross- sectional study conducted in India in 2024 among dental professionals, 85% of the study participants felt the need of concepts of Artificial Intelligence to be included in the postgraduate curriculum.^[14] Majority of the dental professionals felt artificial intelligence may soon replace the human workforce in dentistry and they feared unemployment in the near future, according to a study conducted by

Murali S et al. ^[15] Another study conducted in a South-Indian city among dental professionals also confirmed that the practising professionals had limited knowledge in the utilization of advanced technologies in their practices. Owing to the limited information, their perceptions regarding these advancements were negative. ^[16]

Since limited information regarding artificial intelligence is included in the current syllabus of dental undergraduate students the perception of students about AI remains unclear. To the best of our knowledge, there is no study about South Indian dental students' attitudes and perceptions regarding the application of AI in dental practice. Hence, this study aimed to analyse South Indian dental students' attitudes and perceptions regarding the necessity of incorporating an "AI update" into curriculum and to study any association between year of study and their attitudes.

Materials and methods:

An observational, cross-sectional, questionnaire-based study was conducted using Google forms, a web-based survey platform among clinical dental undergraduate students. Participants were invited to complete the questionnaire remotely. The study was carried out in the summer of 2024. Clinical dental undergraduate students studying in third year (III BDS) and final year (IV BDS) of Bachelor of Dental Surgery course were included in the study. Dental interns were excluded. Those unwilling to participate or provide informed consent were excluded.

Sample size:

Based on previous study, where nearly 50% of undergraduate students have some knowledge about artificial intelligence in dental practice, with a 95% confidence interval and 5% absolute precision, a sample size of 385 was obtained based on following formula: ^[5]

$$n = \frac{Z^2 \cdot p(1 - p)}{E^2}$$

Where:

n = required sample size, Z = Z-value corresponding to the desired confidence level (e.g., 1.96 for 95% confidence), p = estimated proportion of the population (if unknown, 0.5 is often used as it maximizes the sample size) and E = margin of error (expressed as a decimal, e.g., 0.05 for a 5% margin of error).

A list of colleges in the South Indian region was made and 4 clusters, North, South, East and West were formed based on their locations. ^[17] Two schools each were selected from each of these clusters via convenience sampling to obtain the desired sample size. Permission was sought from the heads of institutions of these colleges and email ids of the students were collected through institutional channels. All the third year and final year students studying in these schools were included in the study. Reminder emails were sent, and the online form was kept open for accepting responses until the estimated sample size was reached.

Ethical clearance was obtained prior to the start of the study from the Institutional Ethical Committee and informed consent was obtained from the

participants after explaining the details provided in the participant information sheet. The study was conducted in agreement with the World Medical Association Declaration of Helsinki, 2013.

A self-administered questionnaire was formulated based on the previous studies.^{5, 10, 11} The questionnaire consisted of: 2 questions on their gender and year of study, 10 questions assessing participant's attitudes and 5 questions assessing their perceptions about AI. The questionnaires used in previous literature were listed. Two experts in the field face validated these enlisted questions and questions for our study was finalized upon expert opinion. The logical intent of the questions and the responses sought were verified by subject experts. Face validation of questionnaires also helps in evaluating whether the questionnaire is effective in measuring what it is intended to measure in each population. Students were asked to define their level of agreement, by choosing one of the following values: strongly disagree, disagree, no idea, agree and strongly agree, which were correspondingly scored from 1 to 5. The scores that the participants would achieve would range from 15 to 75; the higher scores indicating better levels of attitude and perception on AI. A pilot study was conducted prior to the commencement of the study. Reliability of the questionnaire was assessed from pilot study by employing the questionnaire on 10% (40) clinical undergraduate students at the author's institute to assess reliability of the pre-validated questionnaire. Cronbach's alpha and intra-class correlation values were found to be satisfactory with Cronbach's alpha value of 0.75. The participants of the pilot study were excluded from main study. A 15-item questionnaire that was validated among dental students was then shared using an

online platform (Google Forms) to all participants of the study. The online form was kept open for accepting responses until the estimated sample size was reached.

Statistical Analysis: All data were entered into a computer by giving coding system, proofed for entry errors. Data obtained was compiled on a MS Office Excel Sheet (v 2019, Microsoft Redmond Campus, Redmond, Washington, United States). Data was subjected to statistical analysis using Statistical package for social sciences (SPSS v 25.0, IBM). Descriptive statistics like frequencies and percentage for categorical data, Mean & SD for numerical data were calculated.

The demographics and distribution of study participants according to their perception of AI is presented using table and graph. The chi-square test was used for assessing any association between categorical data. A p-value of $p < 0.05$ will be considered be statistically significant.

Results:

A total sample size of 385 was attained. Out of the total participants, there were 49 male (12.7%) and 336 (87.3%) female participants. Most of the participants were females in both third year and fourth year of undergraduate dental studies. 220 participants were in third year and 165 participants were fourth year students. The mean attitude and perception score in our study was 57.3 (Table 1).

Table 1: Descriptive data of participants

Characteristic	Year of study		Total
	III BDS	IV BDS	

Gender	Male	30	19	49 (12.7)
	Female	190	146	336 (87.3)
Total		220 (57.1)	165 (42.9)	

When asked about artificial intelligence leading to major advances in dentistry and medicine, third year students gave significantly more positive responses than their final year counterparts ($p < 0.05$), but final year students had a significantly clearer picture to know that artificial intelligence cannot per se replace human physicians or dentists in the future ($p < 0.05$). There were significant differences in the year of study with mean scores pertaining to AI's diagnostic, treatment, prognosis and forensic dentistry applications ($p < 0.05$). Majority of students strongly agreed that AI cannot replace dentists in future, but with mean scores significantly higher among final year students ($\bar{X} = 4.36$ Vs 4.05). (Table 2).

There were no significant differences in the responses when asked about the role of artificial intelligence can be used in the radiographic diagnosis of periodontal diseases, soft tissue lesions of the mouth and pathologies of jaws. Significantly higher ($p < 0.05$) 4th year students knew the application of AI in various diagnostic procedures as compared to 4th year students. Whereas higher proportion of 3rd year students gave positive responses regarding AI use in treatment planning, which was statistically significant. (Table 2) There was a neutral response for artificial intelligence being used as a "quality control tool" to assess the success of treatments and there was no difference in the responses. Most of the students desired that AI

applications be a part of undergraduate and postgraduate training ($\bar{X} = 4.14$ and 4.2 respectively) (Table 2).

Table 2: Evaluation of attitudes and perceptions questionnaire on artificial intelligence in dentistry

Sl. No	Item	Year of study	Mean score (SD)	p-value
1	I think artificial intelligence will lead to major advances in dentistry and medicine.	III BDS IV BDS	3.42 (1.2) 2.95 (1.4)	<0.05*
2	Artificial intelligence, however, cannot replace dentists or physicians in the future.	III BDS IV BDS	4.05 (1) 4.36 (0.8)	<0.05*
3	I find the use of artificial intelligence in dentistry and medicine exciting.	III BDS IV BDS	4.11 (0.8) 4.16 (0.7)	0.51
4	Artificial intelligence can be used as a “definitive diagnostic tool” in the diagnosis of diseases.	III BDS IV BDS	3.13 (1.3) 3.04 (1.3)	0.49
5	Artificial intelligence can be used as a “prognostic tool” to predict the course of a disease and determine whether there is a chance of recovery	III BDS IV BDS	4.01 (0.7) 4.19 (0.7)	0.03*
6	Artificial intelligence can be used for radiographic diagnosis of tooth caries	III BDS IV BDS	4.16 (0.7) 4.29 (0.7)	<0.05*
7	Artificial intelligence can be used in the radiographic diagnosis of periodontal diseases.	III BDS IV BDS	4.06 (0.7) 4.13 (0.7)	0.37

8	Artificial intelligence can be used in the diagnosis of soft tissue lesions of the mouth	III BDS IV BDS	3.21 (1.3) 3.07 (1.5)	0.32
9	Artificial intelligence can be used in 3-dimensional implant positioning and planning	III BDS IV BDS	4.09 (0.7) 4.28 (0.7)	0.01*
10	Artificial intelligence can be used as a “treatment planning tool” in dentistry	III BDS IV BDS	3.30 (1.3) 3.01 (1.4)	0.04*
11	Artificial intelligence can be used as a “quality control tool” to assess the success of treatments.	III BDS IV BDS	3.24 (1.2) 3.03 (1.3)	0.12
12	Artificial intelligence can be used in the radiographic diagnosis of pathologies in the jaws.	III BDS IV BDS	4.07 (0.7) 4.18 (0.7)	0.13
13	Artificial intelligence can be used in forensic dentistry	III BDS IV BDS	4.20 (0.7) 4.35 (0.7)	<0.05*
14	Artificial intelligence applications should be part of undergraduate dental training	III BDS IV BDS	4.07 (0.7) 4.21 (0.7)	0.54
15	Artificial intelligence applications should be part of postgraduate dental training	III BDS IV BDS	4.21 (0.6) 4.19 (0.7)	0.84

Discussion:

Artificial intelligence is the simulation of human intelligence processes by machines, especially by computer systems. ^[18] Within the field of artificial intelligence, machine learning (ML) teaches systems how to operate without prior information or directives. By being exposed to random events and gradually

adjusting the "tuneable" toward the right response, machine learning acquires expertise.^[19-21]

In this study, authors wanted to determine if undergraduate dental students were aware of this concept and if they were aware, they were keen on determining how much knowledge they had regarding the role of AI in dentistry. This 15-item questionnaire not only assessed the role of AI in general dentistry but also assessed its uses in specialities and incorporation of its applications in undergraduate and postgraduate study curricula. Authors found that, most of the students desired AI applications to be a part of undergraduate and postgraduate training.

In the current study, there were more female participants than their male counterparts in each year of study and considering the overall participation, but this could be a result of an increased number of female students enrolled for dental studies when compared to the males. The gender unevenness seen in our study is like the report given by the Dental Council of India (>70% female students) and more so in a study conducted by Muthu J et al. (2015) ($\cong$ 80% female students).^[22,23] Hence, our sample still holds good to be representative of the dental undergraduate student population. South India encompasses 635,780 sq. km area and our study may not represent the entire area, but the mode of data collection was done using an online platform which rules out hindrances in reaching out to people despite an extensive area of population to be covered.

Since the mean score of the participants in our study was 57.3, the present study inferred that the students had positive attitudes towards AI in dentistry.

Significantly higher proportion of younger students believes that artificial intelligence can replace physicians and dentists as compared to their seniors. The results are in contrast with the study conducted by Sajjad I et al (2021), where 83.1% of dental practitioners thought AI would eventually replace doctors, dentists and assistants. ^[24] Whereas, yet another survey on surgeons showed similar results to our study, where 25% of them thought that future advancements in AI would change the nature of their work, and only 4.1% thought AI would replace them. ^[25]

Mean score for AI being used as a prognosis tool to forecast the course of disease was higher in both third and final year students (mean score = 4.1). This is like the results in another study, where early all the participants (96.6%) responded positively. ^[24]

Irrespective of years of study, most of the participants felt the need of improvising the concept of artificial intelligence into both undergraduate and postgraduate training curricula. The findings of our study were coherent with other studies done in different parts of the world. ^[10,11]

Though artificial intelligence is a game-changing concept of this era, it is also necessary to keep in mind that the intelligence acquired by computer is fed to the system by humans using their own intelligence and hence, claiming that artificial intelligence totally replacing physicians and dentists are not logical. However, it will ease humans' workload and help increase the quality of treatment provided by health professionals. ^[25, 26]

Nevertheless, the need for ethical considerations in AI development and implementation has been brought to light due to the risks of algorithmic bias, lack of transparency, data privacy concerns, and accountability in autonomous systems. [26]

The limitations of our study are that, only third and final-year undergraduate students were included in the study and convenience sampling was employed for an easy, quick, cost-effective method of data collection. Some of the limitations that come with convenience sampling like sampling bias, difficulty in replicating the study results and poor external validity also account to the limitations of our study. There was no sub-group inferential analysis done, due to gender unevenness. Even so, these limitations were offset due to the pan-peninsular coverage of the study.

Conclusion:

The current study concludes that undergraduate dental students are aware of the concept of artificial intelligence and its applications. Most of the students desired that AI applications be a part of undergraduate and postgraduate training.

We recommend that universities can initiate execution of educational seminars on AI in dentistry and assess viability of integrating AI instructions into university curriculum and study programs. There lies an immediate necessity to revise the curriculum so that students are trained to follow updated level of dentistry beginning from the undergraduate level and continue evidence-based dentistry governed by artificial intelligence in post graduate level.

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