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Attitude, perception and barriers of dental professionals towards artificial intelligence

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ABSTRACT

Aim: To know attitudes, perceptions and barriers towards the use of Artificial Intelligence (AI) in dentistry in India among undergraduate and postgraduate students.

Methodology: A questionnaire-based cross-sectional study was conducted among participants pursuing graduation and postgraduation. The questionnaire consisted of 23 close-ended and 2 open-ended questions divided into various sections of attitude, perception and barriers. The data was analysed using Statistical Package for Social Sciences (SPSS) version 24.0.

Result: Out of 937 responses, 55.2% responded that they get information about AI from social media platforms. 51.3% of respondents have basic knowledge about the use of AI in dentistry. 59.6% agreed that AI can be used as a “definitive diagnostic tool” in the diagnosis of diseases. 66.5% agreed that AI can be used for radiographic diagnosis of tooth caries. 71.3% stated that AI can be used as a “treatment planning tool” in dentistry. 55.7% stated that AI should be part of undergraduate dental training.

Conclusion: This study concluded that both dental students are aware of the concept of AI. Participants were positive when asked if AI can increase the efficiency of diagnosis, prognosis and treatment planning procedures as well as in managing patient data. Both participants believed that the barriers to the introduction of AI in dentistry are a lack of technical resources and a lack of training personnel in college.

1. Introduction

Artificial Intelligence (AI) is intelligence displayed by computers and robots controlled by computers. The term was first coined by John McCarthy and refers to the idea of building machines that are capable of performing tasks that are commonly performed by humans.¹ It is defined as a field of science and engineering concerned with the computational understanding of what is commonly called intelligent behaviour and with the creation of artefacts that exhibit such behaviour. AI is widely used in various applications like Google, YouTube, Siri, Alexa etc.

As technology is advancing and evolving every day it becomes a necessity to keep pace with newer technologies to produce better results. The same goes for dentistry. The need for such technology arises when

one finds it difficult to keep too many patient records. Also, the chances of making human errors while diagnosing are high, whereas using AI may help in precise and accurate diagnosis.

Machine learning (ML) is one of the branches of AI that researchers and practitioners have applied broadly, using it for data analysis.² Nowadays machine learning has made it possible for a computer to classify or predict an outcome from an extensive database. This processing system was later significantly improved with the breakthrough of deep learning, which enable the computer to process numerous algorithms effortlessly with graphic processing unit brackets (GPUs).³ Due to the evolution of AI, analysis of big data is possible and it provides reliable information and improves the decision-making process. Specifically, in dentistry, It can be used in the diagnosis of various

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pathological structures in the head and neck region like cysts, tumours or metastatic lymph nodes. ML algorithms like Support Vector Machine (SVM) and Random Forest (RF) were used in Cone Beam Computed Tomography (CBCT) to classify these pathologies into various degrees of the risk they possess on the basis of cytological features constructed using the same technology.⁴ Similarly, Convolution Neural Network (CNN) was utilized in staging malignant lesions and in diagnosing high-grade potential malignant lesions.⁴ It is also helpful in diagnosing and treatment planning various oral disorders like temporomandibular joint disorders. It is claimed to accurately detect carious lesions including proximal caries.⁵ These technologies can break down the radiographs in various non-overlapping regions using defined criteria like intrinsic features so that they can be analysed easily and thoroughly.^{6–8} Also robot-based and controlled by AI technology can also be used to perform minor clinical procedures requiring precise handwork. We can use AI technology in diagnosing periodontally compromised teeth, analyzing periapical radiographs, and differentiating aggressive and chronic forms of periodontitis.^{9,10} AI accommodates as a bridge to incorporate conventional diagnosis and microbiological and immunological parameters into periodontal diagnosis.

It may help in determining whether extraction is required or not in treating the malocclusion of a patient. Diagnostic models which are based on lateral cephalometric radiographs are also based on Machine Learning algorithms like Artificial Neural Networks (ANN), and Random Forest (RF) to evaluate skeletal maturation etc.¹¹

AI can also be useful in treatment planning for designing prostheses using the CAD-CAM technique, and in implant positioning.¹⁰ Moreover, efficient data handling which is one of the key aspects of successful clinical practice will become much easier with the help of AI. Therefore, AI can improve dental and clinical practice in future.

Despite so many benefits that AI offers, it still has very limited use in dentistry. There could be a couple of reasons for this like dental students and researchers are not yet completely familiar with the concept and are actually with true potential areas. People are still hesitant to believe in the results offered by AI in robotic-based surgery so there are still a lot of challenges to face. Few studies which were done are generally single centres or involve participants as practitioners, or faculty members in different institutions.^{12–14} To better understand the current status of AI in dentistry, a survey of future dental professionals currently studying in dental colleges across the country is required.

Therefore, this study was conducted to know attitudes, perceptions and barriers towards the use of artificial intelligence in dentistry in India among undergraduate and postgraduate students in different dental colleges. The secondary objective was to know if the addition of AI into the curriculum could enhance their knowledge.

2. Materials and methods

This cross-sectional descriptive study was carried out in different dental colleges. Colleges were selected randomly from the website of the Dental Council of India. Two dental colleges were selected from each zone (north, east, west, and south), so eight colleges were selected for the study. The duration of the study was from August to October 2022. Participants were dental professionals (undergraduate including interns and postgraduate of all specialties) from eight dental colleges.

Inclusion criteria were male and female undergraduates (first year to interns) and postgraduate students (first year to final year) and consented to send replies from selected eight dental colleges. Exclusion criteria were passed-out students, private practitioners, and other employees of the dental college.

The research project was approved by an institutional ethical committee. (XI-PGTSC-II B BDS-S/P7) A questionnaire consisting of 23 close-ended and 2 open-ended questions divided into various sections was prepared. It was prepared as an online form and sent to eight dental colleges through email and WhatsApp. Close-ended questions were of multiple-choice questions having five levels of agreement (strongly

disagree, disagree, no idea, agree, strongly agree). No tracking of replies was used for the anonymity of data. In questionnaire, first section consisted of questions about participants' sociodemographic and educational characteristics. The form also consists of questions about the source from which the participant has perceived knowledge about AI and his/her perception of the scope and application of artificial intelligence in dentistry. Responses were saved in google drive. Validity and reliability were checked before sending the questionnaire. The consent form was included in the questionnaire.

The data were analysed using Statistical Package for Social Sciences (SPSS) software version 24.¹⁵ Statistical calculation was done using a chi-square test and tests for proportions were used wherever applicable. A P-value of less than 0.05 was considered statistically significant.

3. Result

937 participants sent responses from eight dental colleges. Out of 937 students, 10 participants declined participation in the survey. Female participants (67.7%) are more in comparison to male participants (32.3%). 783 (84.3%) participants were undergraduates and 144 (15.7%) participants were postgraduates students (Table 1). Among responses received from undergraduates, 169 (22.1%) belonged to BDS first professional, 211 (27.6%) belonged to second professional, 144 (18.8%) belonged to third professional and 147 (19.2%) belonged to fourth professional while 93 (12.2%) were interns. Among responses received from postgraduates, 56 (50.5%) belonged to the first professional, 7 (6.3%) belonged to the second professional and 48 (43.2%) belonged to the third professional.

Main information source of artificial intelligence was social media (Facebook, Instagram etc) in 55.4%, newspaper magazines etc. in 13.1%, lectures at university in 19.7% and through friends, and family etc in 12.1% of participants. Out of the total responses, 385 (49.17%) undergraduate and 102 (70.83%) postgraduates were aware of AI in dentistry (Figs. 1 and 2). 485 (61.94%) undergraduates and 98 (68.06%) postgraduates have basic knowledge of the working principle of AI and the difference was not statistically significant. (P=0.16).

Regarding attitude towards AI, 400 (51.21%) undergraduates and 72

Table 1
Baseline characteristics and correlation^a of study parameters among participants.

Study parameters	Undergraduates (n = 783)	Postgraduates (n = 144)	P value
Age (in Mean (SD) years),	22.27 (1.98)	28.92 (4.40)	<0.01
Gender, n (%)			
Male	252 (32.18)	47 (32.64)	0.92
Female	531 (67.82)	97 (32.64)	
AI information source N (%)			
Friends, family	98 (12.5)	14 (9.72)	0.12
Newspaper, magazines	107 (13.67)	15 (10.42)	
Lectures in university	144 (18.39)	38 (26.39)	
Social media	434 (55.43)	77 (53.47)	
Knowledge about working principle of AI,	485 (61.94)	98 (68.06)	0.16
Awareness about usage of AI in dentistry	385 (49.17)	102 (70.83)	<0.01
Barrier in use of AI in dentistry			
Lack of awareness	234 (32.37)	84 (58.33)	<0.01
Lack of training personnel in college	384 (53.26)	95 (65.97)	<0.01
Lack of technical resources	387 (53.75)	93 (64.58)	0.02
Non-essentiality in curriculum	201 (27.88)	45 (31.25)	0.41
Not cost effective	198 (27.46)	59 (40.97)	<0.01
Future use is limited	31 (4.31)	11 (7.64)	0.09
Not patient friendly	59 (8.18)	11 (7.64)	0.83

^a Independent sample t-test, chi-squared test and test for proportions were used wherever applicable. P < 0.05 was considered statistically significant.

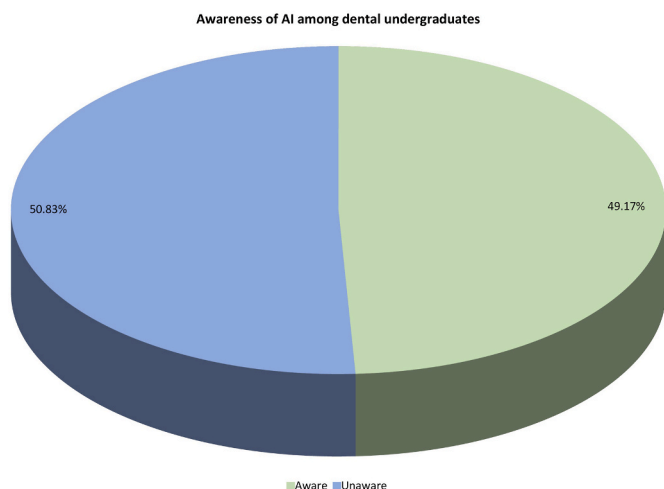


Fig. 1. Awareness of AI among dental undergraduates.

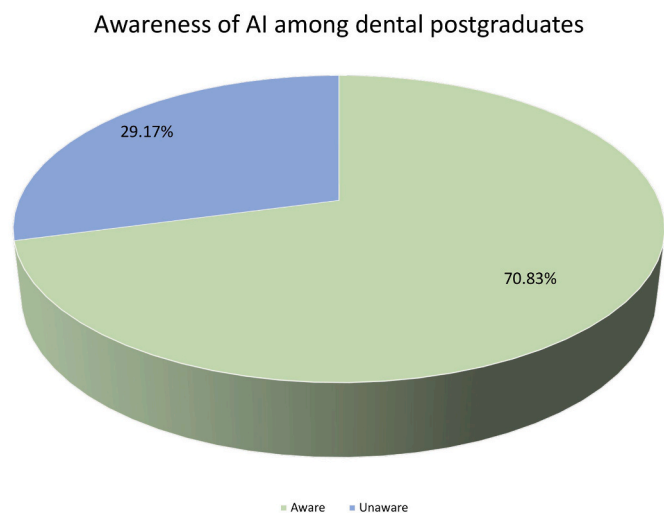
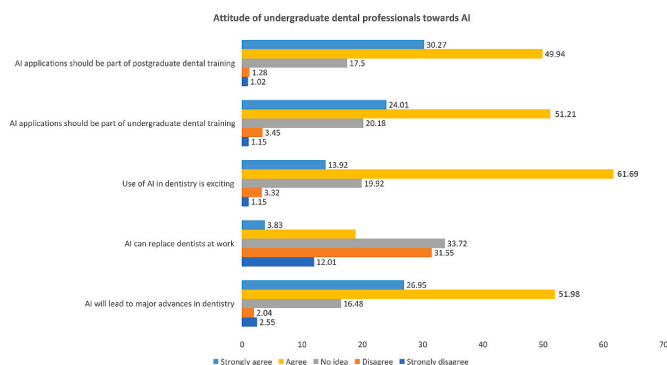


Fig. 2. Awareness of AI among dental postgraduates.

(49.94%) postgraduates agreed that AI applications should be part of undergraduate dental training. 75 (52.08%) postgraduates disagreed that AI can replace dentists at work but 264 (33.72%) undergraduates have no idea about AI can replace dentists at work. 483 (61.69%) undergraduates and 95 (65.97%) postgraduates agreed that the use of artificial intelligence in dentistry is exciting. Both undergraduate and postgraduate participants (407 (51.98%) and 78 (54.17%) respectively) agreed that AI will lead to major advancements in dentistry (Graphs 1



Graph. 1

and 2).

In the section on perception in the questionnaire, there was a slight difference between undergraduates and postgraduates about the agreement that artificial intelligence can be used as a ‘definitive diagnostic tool’ in the diagnosis of diseases. (52.28% undergraduates and 55.04% postgraduates respectively) More undergraduates (70.14%) than postgraduates (59.64%) agreed that AI can be used in forensic dentistry (Graphs 3 and 4). 543 (69.44%) undergraduates and 84 (58.24%) postgraduates, agreed AI can be used as a “prognostic tool” to predict the course of a disease and determine whether there is a chance of recovery.

A significant difference was found when participants were asked about the use of AI as a “quality control tool” to assess the success of treatments. (501 undergraduates and 72 postgraduates) Artificial intelligence can be used as a “treatment planning tool” in dentistry according to 592 (75.69%) undergraduates and 88 (61.43%) postgraduates. Out of the total participants, 532 (68.06%) undergraduates and 78 (54.41%) postgraduates agreed that AI can be used in 3-dimensional implant positioning and planning. A very slight difference was found between undergraduates (69.44%, n = 543) and postgraduates (61.81%, n = 89) when asking about whether Artificial intelligence can be used for radiographic diagnosis of tooth caries.

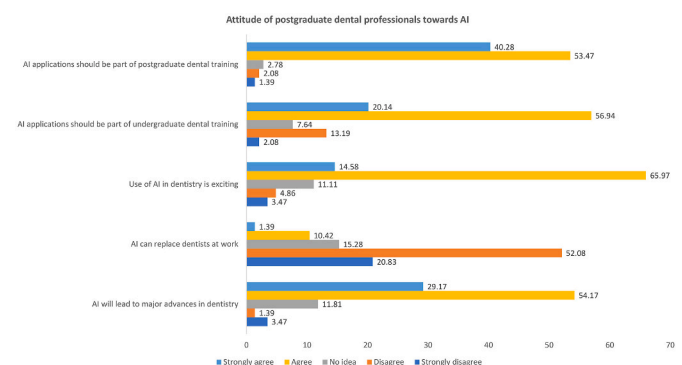
511 (65.28%) undergraduates and 78 (53.9%) postgraduates agreed artificial intelligence can be used in the diagnosis of soft tissue lesions of the mouth. According to 578 (66.7%) participants, lack of awareness is a major barrier to the use of artificial intelligence in dentistry. 480 (55.4%) participants said lack of training in college and lack of technical resources are barriers to the use of artificial intelligence in dentistry. Lack of awareness and lack of training personnel in college between undergraduate and postgraduate show statistically significant differences. (P < 0.01). Participants replied to this question on barriers to the use of AI in dentistry by more than one option.

Non-essentiality in the curriculum is a barrier according to 28.5% of participants (n=247). 30.1% of participants (n=261) agreed that artificial intelligence is not cost-effective. For not being cost-effective, the difference between undergraduate and postgraduate students was statistically significant (P<0.01). Only 5.1% of postgraduates (n=44) and 8.2% of (n=71) undergraduate participants said that AI has a limited future and is not patient-friendly.

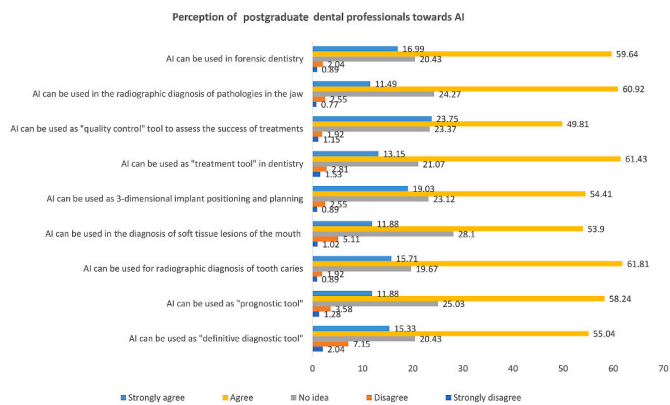
4. Discussion

In the era where technical assistance has a pivotal role, it is very important to not only have knowledge but also we should explore possible uses of technology in the field of dentistry. Utilization of artificial intelligence in combination with the skills of dentists may improve the diagnosis, prognosis and outcome of the treatment.

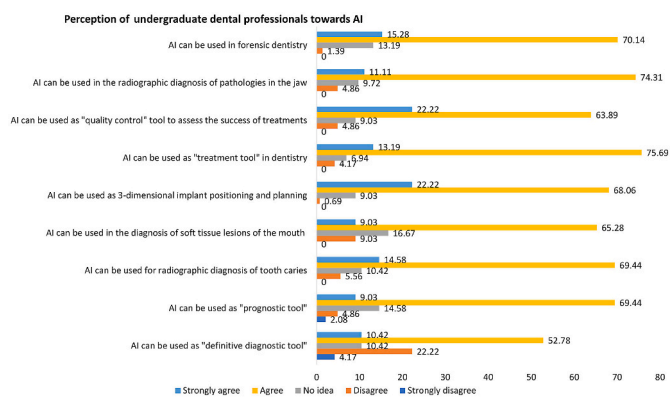
The main source of information on AI is social media, not academics. It indicates that there is a need to teach the basics of AI to undergraduate and postgraduate students, so that students may get adequate pertinent



Graph. 2



Graph. 3



Graph. 4

and evidence-based information in the coming years. Islam et al. have suggested the use of Bolman and Deal’s Reframing Organizations as an infrastructural model to implement AI curriculum in dental colleges.¹⁶

In this survey, while 52.3% of students agreed that including AI would definitely bring major advances in dentistry there was a disagreement that it would completely replace dentists. Divya Tondon et al.¹⁷ also explain that artificial intelligence cannot replace the role of dental surgeons which may be because of the involvement of sensory perception in different dental treatments and also the role of dentist manoeuvrability.¹⁸ Another reason may be that management of the treatment of dental disease needs discussion with patients to build trust, assurance and empathy.

Also, the majority of the population (62.8%) had knowledge about the working principle of AI. However, the awareness and unawareness ratio about the application of AI in dentistry was almost equal. Rohan Sachdev et al.¹⁹ conducted a study to know the awareness and medical students toward artificial intelligence. Out of 401 medical students, the majority of participants (30.9%) strongly agreed about the awareness of AI and 29% of medical students strongly agreed with the scope of integration of AI in medical education in India. These results show once again the interest of dental students in new technologies such as AI and their willingness to learn. Participants emphasized that the basic working principles of AI should be taught in dentistry, as indicated in other studies in the literature.^{4,20}

62.3% of participants found the use of AI is exciting and considered as a ‘definitive diagnostic, prognostic as well as treatment planning tool’. The majority of the participants agreed that AI can be used for radiographic diagnosis of tooth caries, for diagnosing soft tissue lesions of the mouth, for 3D implant positioning and in forensic dentistry. Various studies proposed different models for detecting caries, diagnosing oral pathological lesions, accurate positioning of dental implants

and utilizing data in forensic dentistry.^{7,8,10} There are a few challenges or limitations also like the collection of accurate data, multiple AI models etc.^{21–23}

Almost equally undergraduates and postgraduates participants believed that AI should be part of the dental training program. When asked about the barrier in the way of using AI in dentistry majority said lack of awareness, while lack of training personnel and technical resources also play a part. AI in dental curriculum will help in not only high-quality dental treatment but also precision in diagnosis, treatment planning and prediction of treatment results. It also helps in the unbiased and objective assessment of the students in their clinical, laboratory work, use of materials and equipment etc.²⁴

Most machine learning requires data for training. Exchange of training sets and applying models should be performed with caution to avoid violating HIPAA (Health Insurance Portability and Accountability Act of 1996) regulations. This act provides control to patients about what and how much health information data can be disclosed with maintaining confidentiality and sensitivity.²⁵

Combing data using AI can benefit only when clinicians, researchers, policymakers and industry discuss together to find out the best possible benefit. This not only reduces interpretation errors in future but also improves acceptance and reduces harm to the patient at large.

Limitations of the study include sample size and inclusion of eight dental colleges in order to draw a valid conclusion, yet another limitation of the study was the use of closed-ended questions in which few participants could be more sensitive to few questions, wrong feedback and survey fatigue.²⁶ Few students did not mention their years of undergraduate or postgraduation because they were in the transition period of examination and results. There are various roles of AI in dentistry as in other fields to improve sensitivity and specificity in different applications. To improve and encourage students at the initial level of education and training, it is extremely important to add AI to the dentistry curriculum or regular training. Future studies are suggested to focus on developing models having better accuracy in diagnosing, predictions of outcome assessment of different dental treatments. Also, studies are required to help policy makers to design how and what way AI should be incorporated and assessed for dental students in their curriculum.

5. Conclusion

The majority of participants were aware of the benefits of using AI in dentistry and believed it would be an asset. The study found that better technical resources in clinics and training professionals at undergraduate and postgraduate levels may help overcome future challenges towards using artificial intelligence in dentistry.

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Declaration of competing interest

None.

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