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Knowledge and Awareness in Dental Students Artificial Intelligence in Clinical Practice.

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ABSTRACT

Introduction: Artificial Intelligence (AI) is becoming increasingly relevant in modern dentistry.It assists in diagnosis, treatment planning, and enhances clinical efficiency.In India, dental students are aware of AI but lack structured knowledge.Most learn through informal sources, with minimal academic exposure.

Despite this, students show a positive attitude toward AI integration.
This study evaluates their knowledge, awareness, and perception of AI in clinical practice.

Methods: This study employed a cross-sectional, Questionnaire-based survey design to assess knowledge and awareness among dental students about Artificial Intelligence in dentistry

Results: A total of 123 Undergraduate Dental students participated in the study, with a response rate of 84.82%. According to the demographic breakdown, 33.6% of the pupils were male and 66.4% were female. The majority were in their fourth year (49.2%) and third year (27%) of study.

Conclusion: This study revealed that a significant proportion of Undergraduate Dental students experience moderate to high levels of anxiety during Prosthodontics examinations. The main contributing factors identified were fear of clinical errors, limited preparation time, and perceived examiner strictness. Anxiety levels were generally greater among female pupils and those who performed less academically. These findings highlight the need for targeted interventions, such as stress management workshops, improved exam preparation strategies, and supportive examiner-student interactions, to help reduce exam-related anxiety and enhance student performance and well-being.

Keywords: Dental student anxiety, Academic stress, Prosthodontics examination, Undergraduate, Clinical assessment stress

INTRODUCTION

Artificial Intelligence (AI) is redefining the landscape of modern healthcare, including dental practice. Its potential to streamline diagnostics, enhance clinical decision-making, and improve patient outcomes is increasingly acknowledged by professionals around the world. In India, a country with an ever-expanding population and a need for accessible and efficient dental care, AI holds considerable promise. However, the successful incorporation of AI into dental practice is dependent on how well future dental practitioners—currently undergoing training—understand, accept, and apply this technology in their clinic

While AI is rapidly progressing globally, the Indian dental education system is still in the early stages of adapting to this digital shift. A survey by Ranjana et al. found that although over 70% of Indian dental students had heard of AI, only about 30% had a substantial understanding of its clinical applications[2]. This discrepancy between basic awareness and applied knowledge reflects a broader issue: a lack of structured educational exposure to AI within the dental curriculum.

Most Indian dental students rely on informal learning platforms such as YouTube, social media, or word-of-mouth to understand AI, rather than gaining structured insights through formal education[3]. Consequently, their comprehension of

AI often remains surface-level and theoretical. A cross-sectional survey conducted in Western Maharashtra reinforced this pattern—many students had heard of AI but lacked confidence in its practical application in clinical scenarios[4].

Despite limited hands-on experience, students across India have demonstrated a positive attitude toward AI. In the same Maharashtra-based study, a significant proportion of students acknowledged that AI could enhance diagnostic accuracy, aid in treatment planning, and even reduce procedural errors[4]. These findings echo those of Salunkhe et al., where 60% of respondents agreed that AI could improve efficiency in dental procedures, especially in radiograph interpretation and caries detection[5]

However, students also expressed reservations about over-reliance on AI. Many were concerned that excessive dependence on technology could undermine critical thinking and reduce patient interaction, an essential aspect of dentistry[5]. Empathy, communication, and ethical judgment are considered irreplaceable by machines, a view shared by a majority of respondents in Indian studies[6]. This suggests that students are open to adopting AI but wish to do so without compromising the human elements of clinical care. One of the critical barriers to AI adoption is the unequal distribution of exposure across institutions. Students in urban dental colleges—especially private ones—are more likely to attend AI workshops, webinars, and demonstrations. In contrast, students in rural or government-run colleges often report limited or no exposure to AI-related tools or training[4],[7].

This digital divide emphasizes the need for a standardized AI module in the national dental curriculum, ensuring equal learning opportunities across all institutions. At present, very few dental colleges in India include AI in their syllabi. Most training programs focus on conventional diagnostic and treatment methodologies, with little room for emerging technologies.

Faculty members often lack training in AI themselves, further restricting its academic integration[8]. Several studies have called for capacity building at the faculty level, as well as collaborations with IT and healthcare startups to introduce students to real-world AI applications in dentistry[8]. India's National Education Policy (NEP) 2020 supports technology-enabled learning and interdisciplinary education, making this an ideal time to modernize dental education by incorporating AI[9]. A policy-driven approach could help institutions overcome structural inertia and prepare students for a future that will demand not only clinical skills but also digital literacy.

Students have also voiced ethical concerns surrounding the use of AI in dentistry. In Indian studies, participants questioned who would be held accountable in cases of AI-driven misdiagnosis—the dentist, the software developer, or the institution[10]. Furthermore, worries about patient privacy, data misuse, and legal ambiguities in AI usage were repeatedly highlighted[10]. These findings suggest the need for strong regulatory guidelines and the inclusion of ethics modules in AI training. Postgraduate students have been found to possess slightly more awareness about AI than undergraduates, likely due to their increased clinical exposure and research involvement[5],[6]. However, even among postgraduates, structured learning opportunities related to AI remain sparse. Encouraging students to engage in AI-focused research, simulations, or interprofessional collaborations with engineering departments could enhance their understanding and skill development[7].

AI is also gaining relevance beyond clinical decision-making. Administrative applications such as appointment scheduling, digital patient records, and inventory management systems are increasingly used in private dental setups. Yet, students are rarely introduced to these aspects during their training[4]. A more holistic approach to AI education—covering both clinical and operational uses—would provide students with a comprehensive skill set for real-world practice.

To ensure students are AI-ready, curricular reforms must go beyond optional workshops. AI fundamentals, clinical applications, ethical concerns, and hands-on use of AI-based dental software should be integrated into the core curriculum. AI should be introduced across various specialties, including prosthodontics, oral radiology, orthodontics, and public health dentistry[8],[9]. In conclusion, while Indian dental students exhibit curiosity and a positive outlook toward AI, their actual preparedness is limited by inconsistent exposure, curriculum gaps, and lack of faculty training. Systematic integration of AI into dental education—supported by national policy, academic collaborations, and ethical oversight—can bridge these gaps. Empowering dental students with the right tools, knowledge, and mindset will ensure that AI becomes a valued component of future dental care in India.

METHODOLOGY

This study was designed as a cross-sectional, questionnaire-based survey conducted among Undergraduate Dental students who had exposed to clinics.

Eligible participants included students from theThird year, final year and interns. of the BDS program who had Clinical exposure to Prosthodontics. Students who were unavailable during the data collection period or who declined to give consent were not included in the study.

Data collection was done using a structured, self-administered questionnaire, which consisted of two sections.9
The questionnaire was reviewed for clarity and reliability before being distributed. Participation was entirely voluntary, and all responses were kept anonymous to maintain confidentiality

Statistical Methodology:

Figure 1

3. Results

- A total of 102 dental students participated in the study. Their academic distribution showed that 35.6% were interns, followed by 32.7% in the third year and 31.7% in the fourth year. This indicates a relatively balanced representation across different academic levels, with slightly higher participation from interns.

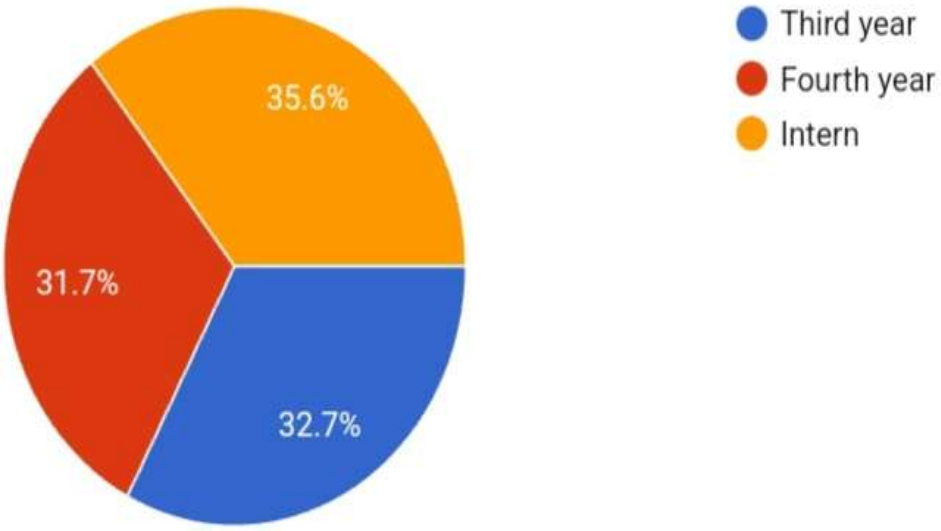
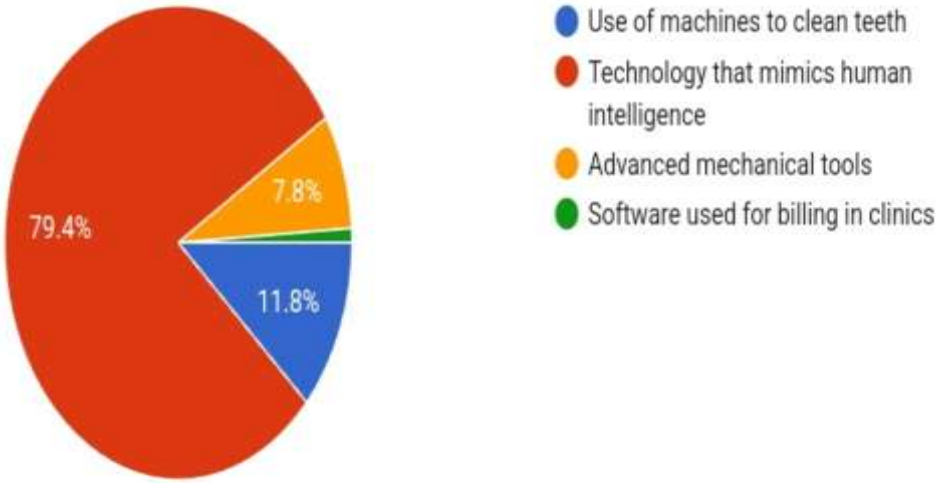
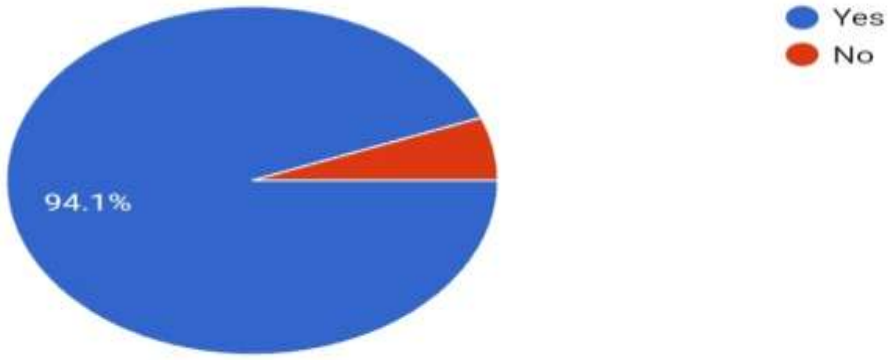


Chart 1

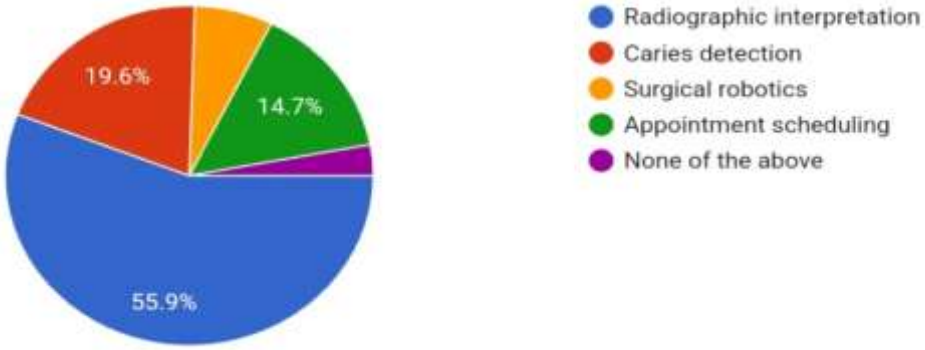
- In terms of understanding AI, 79.4% of students correctly identified AI as a technology that mimics human intelligence and least responded are 1 %



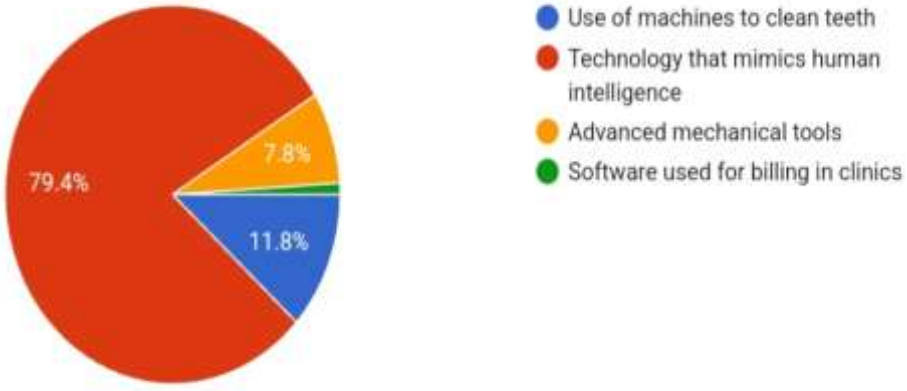
- When asked about their awareness of artificial intelligence (AI) in dentistry, a large majority (94.1%) confirmed that they had heard of AI being applied in the field, while only 5.9% were unaware.



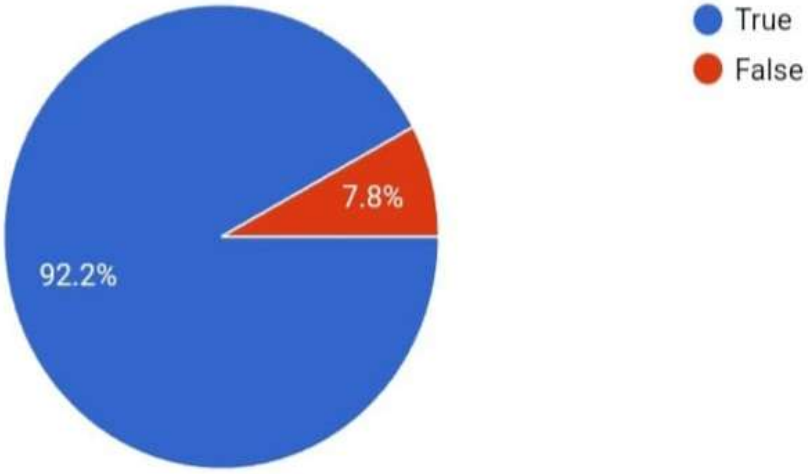
- Students were also asked about areas where AI could be applied in dental practice. The most recognized application was radiographic interpretation, cited by 55.9% of participants.A negligible number of students indicated that AI had no application, reflecting an overall positive outlook toward AI integration.



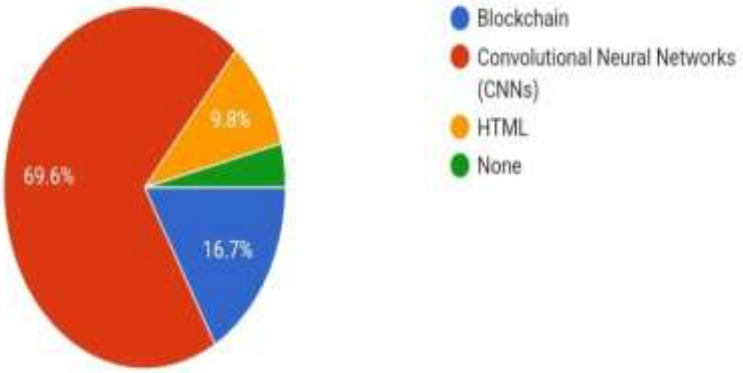
- When we questioned about example of AI application 79.4 % responded to as Al based image analysis.



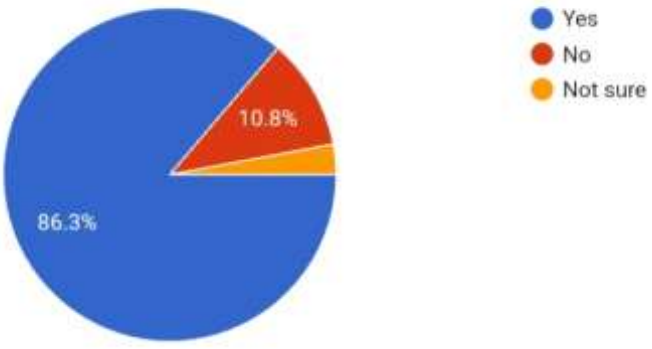
- When we questioned about AI systems can assist in decision-making in clinical diagnosis most responded as true 92.2%.



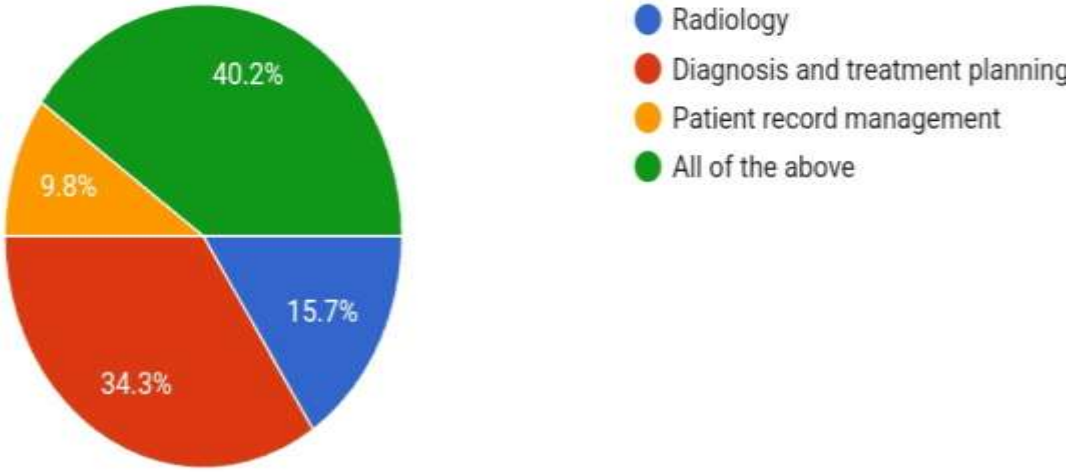
- When we questioned about AI technology commonly used for image analysis most responded to convoluted Neural Networks 69.6%.



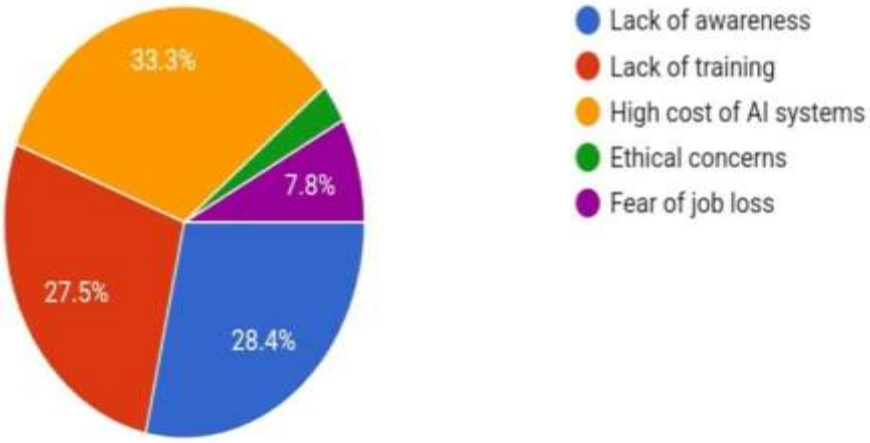
- When we questioned can AI be part of routine dental practice in next 10 years mostly responded as yes 86.3%



- When we questioned about areas in which AI can most helpful in dentistry most of the responded as All of the above 40.2 % such as radiology, Diagnosis and treatment planning and patient record management.



- When we questioned about barriers to AI adoption in dentistry most of them choose as High cost of AI systems 33.3%.



- When we questioned about can you support workshops or elective courses in institution mostly responded yes 97.2%.

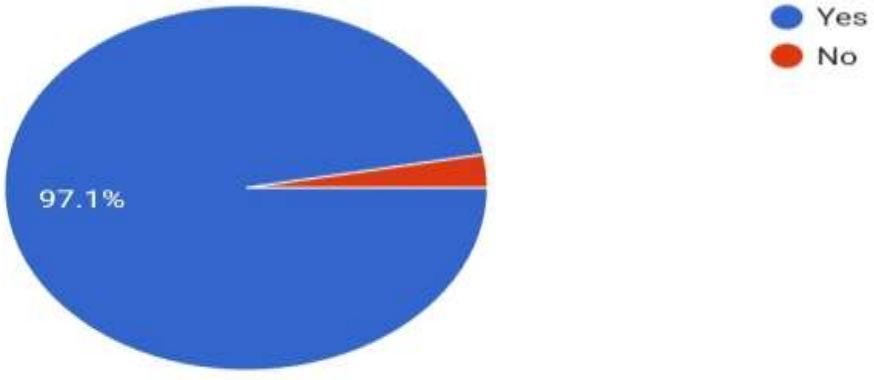


Table 3: Table depicting responses of questionnaire

Questions	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Total
1. What is Artificial Intelligence?	Use of machines to clean teeth (11.8%)	Technology that mimics human intelligence (79.4%)	Advanced mechanical tools (7.8%)	Software used for billing (1%)					**n=102**
2.Have youheard of AI being used in dentistry?	Yes (94.1%)	No (5.9)							**n=102**
3. AI can be used in which of the following areas in dentistry?	Radiographic interpretation (55.9%)	Caries detection (19.6%)	Surgical robotics	Appointment Scheduling (14.7%)	None of above				**n=102**
4. Which of the following is an example of AI application?	ManuManual tooth extraction (15.7%)	AI based image analysis (79.4%)	Traditional impression making	None of above					**n=102**
5. AI systems can assist in decision-making in clinicaldiagnosis ?	True (92.2%)	False (7.8%)							**n=102**
6. Which AI technology is commonly used for image analysis?	Blockchain (16.7%)	Convolutional Neural Networks (69.6%)	HTML	None					**n=102**
7.Do you believe AI will be part of routine dental practice in the next 10 years?	Yes (86.3%)	No (10.8%)	Not sure						**n=102**
8. In which areas do you think AI can be most helpful in dentistry?	Radiology (15.7%)	Diagnosis and treatment planning (34.3%)	Patient record management (9.8%)	All of above (40.2%)					**n=102**
9. What are the barriers to AI adoption in dentistry (choose all that apply)	Lack of awareness (28.4%)	Lack of training (27.5%)	High cost of AI systems (33.3%)	Ethical concerns	Fear of job loss (7.8%)				**n=102**
10. Would you support workshops or elective courses on AI in your institution?	Yes (97.1%)	No							**n=102**

DISCUSSION

The findings of this study provide meaningful insight into the current state of AI awareness and preparedness among dental students in India. Although most students had a general idea about artificial intelligence, their understanding of its specific use in clinical dentistry was limited—particularly when it came to practical applications such as radiographic interpretation, treatment planning, or AI-assisted diagnostics[11]. This is consistent with previous Indian literature, which has also reported that while students are interested in AI, their academic exposure remains insufficient[12].

A significant number of participants indicated that their knowledge about AI came from online platforms like YouTube or social media, rather than through structured lectures or workshops[13]. This suggests a gap between informal curiosity and formal education. Only a few had received any real-time demonstration or hands-on experience with AI tools in a dental setting[14]. Such limited exposure could affect their confidence in using AI tools responsibly in the future.

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Despite these limitations, students maintained a positive attitude toward AI. They saw its value in enhancing clinical efficiency, reducing time-consuming manual tasks, and improving diagnostic accuracy—particularly in radiographic analysis, orthodontic planning, and caries detection[15]. These findings are supported by previous regional studies, including those from Maharashtra and Tamil Nadu, which reported similar optimism about AI among dental students[16].

"Nevertheless, students often expressed worries related to the ethical and legal aspects of using AI in dentistry."Students questioned the reliability of AI-generated outcomes and were unsure who would bear responsibility in the event of a misdiagnosis—the dentist, the software company, or the institution[17]. Many also emphasized the importance of maintaining patient trust, privacy, and the human element in clinical care, all of which they felt might be compromised by over-reliance on machines[18].

Another observation from this study was the difference in AI exposure between students from urban and rural colleges. Those studying in urban, private institutions generally had better access to AI workshops, webinars, and academic collaborations, whereas students from rural or government colleges reported fewer opportunities to interact with or learn about AI technologies[19]. This discrepancy suggests a digital divide that must be addressed through standardized AI training across institutions nationwide.

The study also found that postgraduate students showed slightly greater awareness and readiness to engage with AI. This may be due to their involvement in clinical research, case discussions, and interdisciplinary seminars[20]. Encouraging similar exposure at the undergraduate level through AI-based projects or simulation exercises could significantly improve foundational understanding and confidence.

Interestingly, students were less aware of AI's role in administrative and non-clinical areas, such as appointment management, digital charting, and inventory tracking[21]. These areas are already being explored in private dental clinics, yet they remain largely unaddressed in dental education. This highlights the need for a broader, more holistic AI curriculum—not just focusing on diagnostics, but also on its practice management capabilities.

To prepare dental students for an AI-integrated future, mere theoretical teaching is not sufficient. There is a clear need for structured modules that include practical demonstrations, ethical considerations, interdisciplinary collaboration (with engineering or computer science departments), and real-time problem-solving[22]. Faculty development is equally important, as many educators themselves lack familiarity with AI, which limits their ability to effectively guide students[23].

Overall, the enthusiasm and curiosity shown by dental students are promising. But to harness this potential, dental institutions must move beyond optional workshops and short-term awareness programs. A long-term, policy-supported approach is required, incorporating AI into every level of dental education—from didactic teaching to clinical practice

and research[24]. With proper curriculum reforms, India can develop a generation of digitally literate dental professionals who can use AI not only efficiently, but also ethically and responsibly.

CONCLUSION

Artificial Intelligence (AI) is becoming an integral part of modern dental practice, offering innovative solutions for diagnosis, treatment, and patient management. This study highlights that while dental students in India are familiar with the concept of AI, their depth of understanding and practical knowledge remains limited. The majority of students have encountered AI through informal platforms rather than structured academic teaching, pointing to a gap in the current dental education system.

Despite these limitations, students demonstrate a positive attitude and a willingness to learn about AI, indicating strong potential for future adoption. They perceive AI not as a replacement for clinical skills but as a valuable tool that can support decision-making and improve treatment outcomes. Concerns regarding ethical use and data privacy also reflect a mature awareness of the responsibilities associated with digital technologies in healthcare.

To prepare students for an AI-integrated future, it is essential that dental institutions introduce dedicated modules, practical exposure, and interdisciplinary learning opportunities. Strengthening AI literacy at the undergraduate level will ensure that future dental professionals are equipped to use these technologies confidently, ethically, and effectively in their clinical practice.

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7. Author Contributions:
Anuti Damame was in-charge for the overall conception and design of the study They created the questionnaire, performed the literature analysis, and collected data. They also performed the data analysis and interpretation, and led the writing of the manuscript, including the discussion and conclusion sections.

Dr. Ajay Gaikwad who provided academic guidance throughout the research process. They contributed to refining the study design, supported ethical approvals, and provided critical feedback on the analysis and final draft of the paper.

8. Disclosure
The author declares **no conflicts of interest** related to the content, authorship, or publication of this research.

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