

Assessment of Knowledge & Awareness of Artificial Intelligence (AI) Technology for Implant Placement amongst Dental Students and Professionals in Nagpur City – A Cross-Sectional Study

Dr. Dhananjay Vikas Nagulkar¹, Dr. Akhil Rathi^{2*}

¹Under Graduate Student, Department of Prosthodontics, VSPM's Ranjeet Deshmukh Dental College and Research Center, Nagpur, Maharashtra, 220019

Email: ghananjaynr123@gmail.com

²Associate Professor, Department of Prosthodontics, VSPM's Ranjeet Deshmukh Dental College and Research Center, Nagpur, Maharashtra, 220019

Email: drakhilrathi@gmail.com

ORCID: 0000-0001-8045-7374

*Corresponding Author: Dr. Akhil Rathi, Associate Professor, Department of Prosthodontics, VSPM's Ranjeet Deshmukh Dental College and Research Center, Nagpur, Maharashtra, 220019

Email: drakhilrathi@gmail.com

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ABSTRACT

Background:

Artificial Intelligence (AI) has significantly impacted various fields, including dentistry, by enhancing diagnosis, treatment planning, and placement accuracy. Despite its growing role, there is limited research on AI's impact on implant placement and varying levels of awareness among dental professionals.

Aim:

To evaluate the knowledge and awareness of AI technology in implant placement among dental interns, postgraduate students, and dental practitioners in Nagpur City.

Materials and Methods:

A cross-sectional survey involving 210 participants (70 dental interns, 70 postgraduate students, 70 practitioners) was conducted using a validated 12-question questionnaire. Data were analyzed using SPSS version 21.0, applying Chi-square and Mann-Whitney U-tests for statistical significance.

Results:

The response rate for study was 71%. All groups were aware of AI, formal education in AI was limited, with only 7.8% of interns, 9.8% of postgraduates, and 9.65% of practitioners receiving formal training. Interns and postgraduates exhibited higher familiarity with AI applications in implant dentistry compared to practitioners. Interns and postgraduate students were generally more familiar with AI applications and supportive of its integration into dental practices. In contrast, practitioners showed varied levels of familiarity and were more divided on the effectiveness and potential of AI. Opinions on AI's impact on human roles in implant dentistry came to a consensus that AI will prove a supplemental tool rather than reducing the role of humans.

Conclusion:

AI has great potential to enhance dental practice, especially in implant dentistry, but its integration requires addressing educational gaps and increasing acceptance among professionals. Adoption will depend on research, validation, and a balanced approach that combines AI benefits with the irreplaceable value of human expertise. Well-designed training/capacity building programs need to be conducted for dental professionals in order to improve integration of AI in routine dental practice.

Keywords: Artificial Intelligence, AI, Implants

Conflict of interest: None

Introduction

The world has been revolutionized by the development and implementation of Artificial Intelligence in various aspects of life. Artificial Intelligence imitates the cognitive process of human intelligence by using machines and complex algorithms to manage complex tasks^[1]. In recent years, the field of dentistry has also witnessed a remarkable transformation due to the integration of Artificial Intelligence (AI) into its practices. As technology continues to advance at an unprecedented pace, AI has emerged as a powerful tool in the field of implant dentistry, revolutionizing the way dental professionals approach diagnosis, treatment planning, and patient care. AI plays a crucial role in data analysis and decision-making. AI algorithms can process vast amounts of patient data, including medical history, diagnostic imaging, and treatment outcomes, to provide valuable insights and assist dentists in formulating personalized treatment plans.^[2] AI models have also used dental radiographs to diagnose different lesions such as periodontal disease^[3,4,5] or dental caries.^[6]

In 2003, a systematic search found over 2000 types of dental implants according to implant type, manufacturer^[7]. The broad variability of dental implant types presents a challenging problem for dental professionals.^[7,8] Different AI models have been developed for image recognition of the implant type by using periapical and panoramic radiographs.^[9,10] Similarly, AI applications have been reported for developing prediction models to determine osteointegration success or implant prognosis by using patient risk factors and ontology criteria, as well as optimizing dental implant designs by combining finite element analysis (FEA) calculations and AI models^[11]. This fusion of cutting-edge AI algorithms with the science and art of dental implantology has opened new horizons, enabling clinicians to provide more precise, efficient, and condition-specific solutions for the restoration of dental function and aesthetics. However, an analysis of the development performance of AI methodology and its potential influence on implant dentistry for surgical and placement protocol is lacking. Therefore, in this study, we evaluated the knowledge & awareness of Artificial Intelligence technology in Implant Placement among dental interns, postgraduate students & dental implant practitioners in Nagpur city.

Aim

To Assess the Knowledge & Awareness of Artificial Intelligence technology in Implant Placement among Dental Students and Professionals in Nagpur city

Objective

1. To evaluate the awareness levels of AI applications in dental implantology among Dental Interns, postgraduate students and dental practitioners.
2. Investigate the attitudes and perceptions of dental students and practitioners toward AI technology in implant placement
3. Compare the knowledge and awareness levels of AI in implant placement between dental undergraduate, postgraduate students and experienced dental implant practitioners

Materials and methods

The Questionnaire was sent to 210 individuals of which 150 responded. This included Dental Interns, Postgraduate students of specialties that practice implantology of various Dental Colleges & Private implant practitioners in Nagpur City. The participants were personally approached by the investigator, and response rate for study was 71%.

The study was conducted using a self-directed, comprehensive, validated Questionnaire with 10 close ended and 2 open ended questions [Table 1]. This questionnaire was designed to gather insights from dental professionals on their experiences and opinions regarding the use of Artificial Intelligence (AI) in dental practice.

It starts by assessing the respondents' awareness of AI, including whether they have received formal education or training on the subject and if they have incorporated AI into their current practice.

Next, the questionnaire explores the perceived benefits of AI in dentistry. It asks professionals to consider its potential to enhance various aspects of dental procedures, such as improving diagnostic accuracy and treatment outcomes.

Finally, the questionnaire looks toward the future, asking respondents to consider the evolving role of AI in dentistry and any ethical concerns it might raise. The overall aim is to understand how AI is currently being used in dental practices, its perceived advantages, and what the future

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may hold for AI in the field of dentistry.

Section 2: Questionnaire

- Are you aware about the concept of Artificial Intelligence?
 - ☐ Yes
 - ☐ No
- Have you received any formal education or training on AI technology in dental implant placement?
 - ☐ Yes
 - ☐ No
- Have you integrated AI technology into your dental implant placement practice?
 - ☐ Yes
 - ☐ No
- If yes, which AI technologies or tools do you use for implant placement? (Please list)
- Please rate your level of familiarity with the use of AI in implant dentistry.
 - 1: Very unfamiliar 2: Unfamiliar 3: Somewhat familiar
 - 4: Familiar 5: Very familiar
- AI technologies can be easily integrated into current implant dentistry practice?
 - 1: Strongly Disagree 2: Disagree 3: Neutral 4: Agree
 - 5: Strongly Agree
- AI systems can improve the accuracy of diagnosis and evaluation of dental implant candidates.
 - 1: Strongly Disagree 2: Disagree 3: Neutral 4: Agree
 - 5: Strongly Agree
- AI can assist in identifying suitable implant materials and designs for specific cases.
 - 1: Strongly Disagree 2: Disagree 3: Neutral 4: Agree
 - 5: Strongly Agree
- AI can improve the accuracy of implant placement in dentistry?
 - 1: Strongly Disagree 2: Disagree 3: Neutral 4: Agree
 - 5: Strongly Agree
- As a practitioner, how likely will you be to undergo an (implant) treatment plan formulated by artificial intelligence?
 - 1: Extremely unlikely 2: Unlikely 3: Neutral 4: Likely
 - 5: Extremely likely
- Do you think that in future AI Technology will lead to lessen the role of human involvement in field of dentistry?
 - 1: Strongly Disagree 2: Disagree 3: Neutral 4: Agree
 - 5: Strongly Agree
- How do you foresee the role of AI technology evolving in dental implant placement in the next 5-10 years? (open-ended)
- Are there any ethical concerns related to AI in implant dentistry that you think should be addressed? (open-ended)

Figure 1 : Questionnaire

Data was imported to SPSS VERSION 21.0 (SPSSInc, Chicago, IL) statistics software to draw means and Percentage. Chi-Square test was done to find if any significant difference existed between the participants of the study according to their responses and the questions with Likert scale options were analyzed using Mann-Whitney U-test. Test cutoff level for statistical significance was fixed at 0.05. The samples were also divided according to current position (dental intern, postgraduate students, private practitioners)

Results

The research surveyed 150 dental professionals, including 50 dental interns, 50 post-graduate students, and 50 dental practitioners. All groups were aware of Artificial Intelligence (AI), but formal education varied. Formal training in AI was rare, with only 7.8% of interns, 9.8% of post-graduates, and 9.65% of practitioners with training in AI.[Figure 2] Post-graduate students and interns were generally more familiar with AI in implant dentistry, with 43.1% of post-graduates and 23.5% of interns considering themselves familiar. Practitioners were less so, with opinions ranging from very unfamiliar (12.3%) to familiar (28.1%).

Regarding AI integration, 82.4% of post-graduates and 52.9% of interns agreed it could enhance implant procedures, while practitioners were divided, with only 35.1% agreeing [Figure 3].

The opinions on AI improving diagnosis accuracy followed a similar pattern, with 68.6% of interns and 78.4% of post-graduates agreeing, but practitioners showed more varied responses. [Figure 4]

In terms of AI's role in identifying implant materials, 66.7% of interns and 70.6% of post-graduates agreed AI could help, while 43.9% of practitioners agreed [Figure 5]. For improving implant placement accuracy, 70.6% of interns and 78.4% of post-graduates supported the idea, compared to 42.1% of practitioners.

When asked about accepting AI-based treatment plans, 51% of interns and 54.9% of post-graduates agreed, while 31.6% of practitioners were supportive.

On whether AI will reduce human roles in dentistry, 54.9% of post-graduates agreed, while practitioners remained skeptical. [Figure 6]

Discussion

The findings of this study underscore the diverse perspectives and varying levels of familiarity with Artificial Intelligence (AI) among different groups of dental professionals, namely dental interns, post-graduate students, and dental practitioners. The data revealed several key insights into the awareness, education, and attitudes towards the integration of AI in dental practices, particularly in the context of implant dentistry.

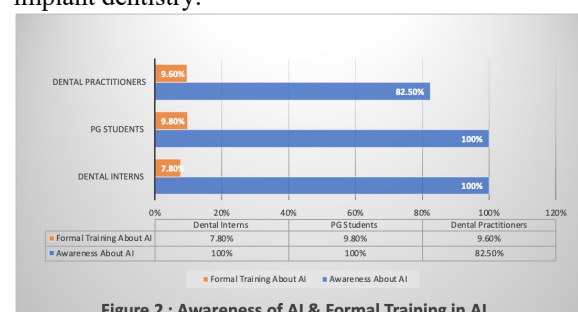


Figure 2 : Awareness of AI & Formal Training in AI

1] Awareness and Formal Education in AI

Awareness of AI was widespread, with 100% of dental interns and post-graduate students familiar with the concept. Among dental practitioners, awareness was lower, at 82.5%, particularly among older professionals. Younger practitioners showed higher familiarity, possibly due to greater exposure to AI through modern technology like smartphones and computers. However, formal education in AI was lacking across all groups, with only a small percentage receiving any training. This highlights a gap in dental education, suggesting the need for more AI-focused content to better equip future practitioners for the increasing role of technology in dentistry.

2] Familiarity with AI in Implant Dentistry

Post-graduate students and interns showed greater familiarity with AI in implant dentistry compared to practitioners, likely due to more recent exposure to modern education. Many practitioners, especially older ones, were unfamiliar or only somewhat

familiar with AI, which may hinder its adoption in clinical practice. Younger practitioners, however, were generally more open to integrating AI technologies.

3] Perceptions of AI Integration and Effectiveness

Dental interns and post-graduates largely agree on the benefits of AI in improving diagnosis and implant placements, seeing it as easily integrable into practice. In contrast, practitioners were more divided, with many remaining neutral or skeptical, possibly due to limited exposure to AI or a preference for traditional methods.

4] Opinions on AI in Diagnosis, Implant Materials, and Placement Accuracy

The study found that dental interns and post-graduates are optimistic about AI's potential to improve the accuracy of diagnosis, implant candidate evaluation, and material selection, showing a readiness to adopt AI tools. In contrast, many practitioners were more conservative, favoring traditional methods due to concerns about AI's reliability. Studies by Kwak et al.^[12] and Oliveira-Santos et al.^[13] demonstrated AI's success in detecting the mandibular canal, suggesting AI's role in future implant planning. Altalhi et al.^[14] noted AI's potential in identifying implant brands, addressing challenges when clinicians lack access to prior treatment details. Currently, two systems exist for implant detection, a website – www.whatimplantisthat.com and a system developed by Michelinakis et. al.^[8] both requiring human input, which introduces potential errors. AI could eliminate this by automating implant identification. According to Revilla-León et al.^[15], AI models show high accuracy (93.8% to 98%) in recognizing implant types using radiographic images and can optimize implant designs, though further research is needed to improve these models.

5] Acceptance of AI-Formulated Treatment Plans and Future Role of AI in Implant Dentistry

Dental interns and post-graduates were more open to AI-formulated treatment plans, viewing AI as a valuable clinical tool. Practitioners, however, were less trusting, preferring human oversight in care decisions. Opinions varied on AI reducing human involvement—post-graduates were more accepting, while interns and practitioners were skeptical, likely due to concerns over job security and the human

touch in patient care. Despite limited developments in AI for implant dentistry, most agreed AI would serve as a supplemental tool rather than replacing human decision-making.

Studies by Elgarba^[16] and Liu^[17] support this view, showing AI can complement human expertise but not fully replace it. Altalhi^[14] also noted AI's potential to predict implant outcomes, addressing complications and risks in implantology.

Conclusion

This study highlights significant disparities in the awareness, familiarity, and attitudes toward the integration of Artificial Intelligence (AI) in dental practices, particularly in implant dentistry, among dental interns, post-graduate students, and dental practitioners. While there is a high level of awareness of AI among the younger generation of dental professionals, including interns and post-graduate students, this awareness does not always translate into familiarity with AI applications, especially in specialized areas such as implant dentistry. The study also underscores the lack of formal education in AI across all groups, pointing to a need for curriculum enhancements that can better equip future practitioners with the knowledge and skills required to leverage AI in clinical practice.

The generational divide is evident, with younger professionals being more receptive to AI's potential in improving diagnosis accuracy, implant placement, and treatment planning. However, dental practitioners, particularly those from older age groups, display more skepticism and a preference for traditional methods. This cautious approach may stem from concerns about the reliability of AI systems, the potential reduction in human involvement in patient care, and a general unfamiliarity with newer technologies.

Overall, the study suggests that while AI holds significant promise for enhancing dental practice, particularly in implant dentistry, its successful integration will require addressing the educational gaps and fostering a greater acceptance of AI-driven tools among all dental professionals. Encouraging the adoption of AI will likely depend on continued research, validation of AI models, and a balanced approach that combines the benefits of AI with the irreplaceable value of human expertise in dentistry.

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