International Journal Dental and Medical Sciences Research
Volume 6, Issue 1, Jan-Feb- 2024 pp 122-131 www.ijdmsrjournal.com ISSN: 2582-6018

Artificial Intelligence and Its Impact on Dentistry

[1] Shreya Poduval, [2]Dr. Jyothsna Vittoba Setty, [3] Dr. Shilpa S, [4]Dr. Ila Srinivasa
Undergraduate Student, M. R. Ambedkar Dental College, Bengaluru, Karnataka
Professor, Dept. Of Pediatric Dentistry,Sri Siddhartha Dental College and Hospital, Tumkur, Karnataka
Postgraduate Student, Dept. Of Pediatric Dentistry, M.R. Ambedkar Dental College and Hospital, Bengaluru, Karnataka
,Professor and Head of Dept., Dept. Of Pediatric Dentistry, M.R. Ambedkar Dental College and Hospital, Bengaluru, Karnataka

Date of Submission: 05-01-2024 Date of Acceptance: 15-01-2024

ABSTRACT: This study explores the integration of Artificial Intelligence (AI) in dentistry, focusing on dentists' knowledge, awareness, perspectives and acceptance. With the worldwide incorporation of AI in several fields including dentistry there has been a need for further understanding in this respect. An online survey with 403 participants was conducted to understand the potential benefits of AI for research and software development. The study found that while some responses were affirmative, others suggested that AI might not be suitable for the Indian dental scenario. This paper underscores the need for a nuanced approach to AI adoption in dentistry, especially in a diverse land like India.

KEYWORDS: Artificial Intelligence, AI,Dentistyry, awareness, acceptance, dentistry.

I. INTRODUCTION

Researchers have spent decades decoding the human neural network and creating a similar learning pattern in machines [1]. This has led to the development of Artificial Intelligence. Coined in 1956[2], artificial intelligence in its broader sense involves computer software that can mimic human thinking based on previously stored information [3]. In the events of modern science and technology, few innovations have had as profound an impact as Artificial Intelligence (AI), an amalgamation of software and human intelligence [4], artificial intelligence has opened a plethora of unexplored possibilities across various areas. The field of dentistry holds an immense opening to the transformative potential of AI. By leveraging machine learning, image recognition, and natural language processing, AI has brought along with itself a new era in oral healthcare.[5]

Diagnostic sector of dentistry has shown noteworthy benefits from the use of artificial intelligence [6]. Advanced imaging techniques in AI assists in the early detection of dental anomalies, including detection in patients with caries [7], impacted supernumerary teeth [8], periapical pathologies and even oral cancers [9]. Moreover, AI-powered diagnostic tools improve the precision of treatment planning, ensuring tailored treatment plans that maximise prognosis [10].

Treatment execution has also immensely benefited from the use of AI. These algorithms have helped guide robotic features and facilitate delicate surgical procedures such as orthognathic surgery [11] and implant placement procedures [12], thereby minimising invasiveness and helping with a speedy recovery. Artificial Intelligence driven systems also aid in the design [13] and fabrication of prosthesis achieving levels of precision that may have been considered practically unattainable [14]. Artificial Intelligence has shown immense improvement in pain control using Virtual Reality distraction during scaling and root planning procedures [15]. Artificial Intelligence swooping into dentistry has begun a plethora of applications, enhancing standard, efficiency and penetrability of dental care [4]

Incorporation of AI has improved diagnostic acumen of practitioners and enhanced accuracy of treatment [16]. Automation of tasks has led to improved treatment methodologies while attempting to keep it more cost efficient. It has also played a pivotal role in broadening the reach of dentistry as tele dentistry continues to gain traction.[17]

However, as it is with revolutionary technologies, the incorporation of AI in dentistry comes with its own challenges and concerns. As this increases data digitisation demands, so does the concern for insufficient data collection [18], security, privacy and optimal usage of this patient data.[19] Over-reliance on technology also can lead to a compromise of clinical judgement [20], technical lapses and the interpersonal aspects of dentistry [21]. Incorporation of AI can also threaten

loss of jobs and supererogatory automation of tasks.[22] This amalgamation of technology and healthcare also necessitates regulatory guidelines and ethical framework to ensure transparency and accountability [23].

As dentists around the world have begun to incorporate artificial intelligence into their practice and academic lives, there has been a need to understand and evaluate the form and acceptance of the same [24]. In a country where the incorporation of AI in dentistry could affect the oral healthcare of nearly one sixth of the world's population, it is essential to know a practitioners view on the same [25]. A need for a comprehensive study on the integration of this technology is palpable among developers and dental practitioners, especially for a country like India with such a vast array of oral health care needs. This presents a compelling case for such customised understanding in comparison to its counterparts with a more homogenous population [26].

With a shortage of skilled professionals particularly in rural areas, AI powered tools can help with multiplication of force and resources.[25]

However, the idiosyncrasies of the Indian dental landscape must be understood before the deployment of this technology. Tailoring the AI tools with the understanding of the Indian dental scene can help in alleviating concerns with its use [27] while helping with cost optimisation [28], adapting to current levels of willingness of dentists to accept this new technology [29] and hopefully transitioning the patients from primarily restorative to preventive dentistry [30]. The authors of this research have used these requirements and concerns to frame the questionnaire and subsequently the study. This study is aimed at providing insights into the practicality and feasibility of AI applications in their daily tasks, which is often overlooked in more technically-focused studies. It also gauges the acceptance level of AI among dentists, a key factor in successful implementation. Moreover, it can identify potential barriers or challenges that dentists might face in adopting AI, enabling the development of targeted solutions. Lastly, such a survey can help shape future AI tools to be more user-friendly and effective, ultimately enhancing patient care and improving dental health outcomes.

II. METHODOLOGY

After obtaining ethical clearance from the Institutional ethical committee and Review Board (IEC/ MRADC&H/ EC-056/2023), a cross-sectional study was conducted among dentists from various states and Union Territories. Four hundred and three randomly selected dental surgeons from various parts of India participated in this survey through Google Forms. Among the 403 participants, 111 were dental house surgeons, 139 were general dentists,51 were post-graduate students and 102 were specialists in their respective departments. A self-structured questionnaire consisting of 25 questions was framed on Google Forms (Google LLC, Mountain View, California, United States) out of which the first 6 questions focused on obtaining demographic details including age, gender, place of practice and qualifications. The remaining 19 questions were used to assess the knowledge about AI using the computer enabled questionnaire Google form which was submitted online. All the participants were explained the purpose of the study and consent was obtained through Google Forms. Completed questionnaire was subjected to statistical analysis and the results were drawn using Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp.

III. RESULTS

The study included participation from across India, where 41.7% were male and 58.3% were female. The participants' ages ranged from 20-59 years, where the mean age was 32 years. Majority of the participants aged between 20-30 years (58.0%). General dentists (34.5%) formed a larger mass of participants. Subjects who were associated with an academic institution formed a greater part of the study (39.5%). Those who were practising for less than 3 years formed the majority of the participant pool. (40%). Of the subjects, 76.2% had heard about the use of Artificial Intelligence in dentistry before and 71% were familiar with the concept of Artificial Intelligence (AI) and its potential applications in dentistry. Majority of participants (37.0%) agreed that the use of Artificial Intelligence in dentistry can improve patient care which was statistically significant ($p=0.03$). Image analysis and interpretation (69.0%), Predictive analytics for oral health outcomes (52.9%) and Patient communication and education (47.6%) were the most common areas of dentistry that the participants believed could benefit most from incorporation of Artificial Intelligence. Diagnosis and treatment planning was accepted as another field benefitting from AI incorporation as per participants, with those with less than 5 years of experience agreeing in greater percentage than those with greater than 5 years of experience with a p value = 0.004, making it statistically significant. Similar significance was

International Journal Dental and Medical Sciences Research
Volume 6, Issue 1, Jan-Feb- 2024 pp 122-131 www.ijdmsrjournal.com ISSN: 2582-6018

seen with Image analysis and interpretation, where 73.6% of the participants with lesser than 5 years of experience were seen to agree while only 63.7% of participants with greater than 5 years of experience agreed (p= 0.04). Of the participants, 43.4% were fairly confident on the accuracy and reliability of AI-based diagnostic systems when compared to traditional methods. Cost of AI technology (64.8%), ethical considerations (63.0%) and lack of training and education on AI for dental professionals (57.8%) were the most agreed upon challenges foreseen in the implementation of AI in dentistry in India. Analysis also shows that lack of training and education on AI for dental professionals was a common concern for AI integration among 63.7% of dentists with lease than 5 years of experience while only 50.0% of those with more than 5 years of experience agreed with this(p=0.008). Among the participants, 71.0% had not personally used any AI-based tools or technologies in their dental practice. Administrative tasks (56.1%), patient follow ups (52.6%) and business tasks (46.2%) were the most common areas of daily practice that could be enhanced by use of AI. Treatment prognosis (51.6%) is a field in dental care that was majorly agreed to be enhanced by incorporation of AI in dentistry. The receptionist task (63.8%) was believed to be most likely replaced by use of AI into daily practice. Travel/ Daily commute (63.8%) was the most beneficial aspect from their daily life with respect to involvement of AI. Likeliness of incorporating AI in their practice was seen among 35.8% participants. Slight incomprehension (32.8%) was the most common response on understanding of legalities involving use of AI in dentistry while 37.7% were neutral about the responsible and ethical use of AI in dentistry. Disparity was seen between the two experience groups, that is those with lesser than 5 years of experience and those with greater than 5 years of experience on the legalities involving use of AI where the p value was 0.002 making it statistically significant.

Majority of participants (35.2%) considered it important to stay updated on the latest advancements and research related to AI in dentistry and 50.9% were interested in attending workshops/ training programs focused on AI in dentistry to enhance their understanding and skills.

Distribution of Sociodemographic characteristics among study participants			
Variable	Category	N	%
Age	20-30 yrs.	233	58.0%
	31-40 yrs.	98	24.4%
	41-50 yrs.	58	14.4%
	51-60 yrs.	13	3.2%
		Mean	SD
	Mean	31.38	8.66
	Range	20-59	
Gender	Males	168	41.7%
	Females	235	58.3%

Table 1 Distribution of Sociodemographic characteristics among study participants

Distribution of Professional characteristics among study participants			
Variable	Category	n	%
Profession	UG Student	25	6.2%
	PG Student	51	12.7%
	Intern	86	21.3%
	General Dentist	139	34.5%
	Specialist	102	25.3%
Years of active practice (If	< 3 yrs.	161	40.0%
	3-5 yrs.	51	12.7%

International Journal Dental and Medical Sciences Research
Volume 6, Issue 1, Jan-Feb- 2024 pp 122-131 www.ijdmsrjournal.com ISSN: 2582-6018

applicable)	5-8 yrs.	55	13.6%
	8-15 yrs.	65	16.1%
	> 15 yrs.	40	9.9%
	Not applicable	31	7.7%
Type of the work	Associated with an academic institution	159	39.5%
	Private Practice	198	49.1%
	Both	28	6.9%
	Others	18	4.5%

Table 2 Distribution of Professional characteristics among study participants

Comparison of participants' responses to the study questionnaire based on their years of Practice using Chi Square Test

Questions	Responses	≤ 5 yrs.		> 5 yrs.		p-value
		n	%	n	%	
Have you heard of or read about AI being used in dentistry before?	Yes	170	80.2%	121	75.6%	0.29
	No	42	19.8%	39	24.4%	
How familiar are you with the concept of Artificial Intelligence (AI) and its potential applications in dentistry?	Very Familiar	17	8.0%	18	11.3%	0.37
	Somewhat Familiar	151	71.2%	116	72.5%	
	Not Familiar	44	20.8%	26	16.3%	
Please rate your opinion on the use of AI in dentistry and its potential to improve patient care	Strongly Disagree	9	4.2%	3	1.9%	0.03*
	Disagree	19	9.0%	28	17.5%	
	Neutral	68	32.1%	42	26.3%	
	Agree	76	35.8%	66	41.3%	
	Strongly Agree	40	18.9%	21	13.1%	
Which areas of dentistry involving patients do you believe could benefit the most from incorporating AI?	Diagnosis and treatment planning	106	50.0%	56	35.0%	0.004*
	Image analysis and interpretation	156	73.6%	102	63.7%	0.04*
	Patient communication and education	104	49.1%	82	51.2%	0.68
	Predictive analytics for oral health outcomes	116	54.7%	84	52.5%	0.67
	Robot-assisted dental procedures	89	42.0%	70	43.8%	0.73
	None	2	0.9%	5	3.1%	0.13
How confident are you in the accuracy and reliability of AI-based diagnostic systems when compared to traditional methods?	Not Confident	9	4.2%	5	3.1%	0.25
	Only slightly confident	31	14.6%	33	20.6%	
	Fairly Confident	100	47.2%	59	36.9%	
	Confident	61	28.8%	55	34.4%	
	Very Confident	11	5.2%	8	5.0%	

What concerns or challenges do you foresee in the implementation of AI in dentistry?	Privacy and security of patient data	86	40.6%	65	40.6%	0.99
	Ethical considerations	132	62.3%	107	66.9%	0.36
	Cost of AI technologies	140	66.0%	101	63.1%	0.56
	Integration with existing dental practice management systems	102	48.1%	84	52.5%	0.40
	Lack of training and education on AI for dental professionals	135	63.7%	80	50.0%	0.008*
	None	1	0.5%	1	0.6%	0.84
Have you personally used any AI-based tools or technologies in your dental practice?	Multiple	3	1.4%	4	2.5%	0.63
	Few	17	8.0%	16	10.0%	
	One	38	17.9%	33	20.6%	
	None	154	72.6%	107	66.9%	
What specific tasks or aspects of your daily practice do you think could be enhanced by AI technologies?	Business Tasks	98	46.2%	78	48.8%	0.63
	Administrative Tasks	117	55.2%	97	60.6%	0.29
	Diagnosis	84	39.6%	46	28.7%	0.03*
	Treatment Planning	96	45.3%	63	39.4%	0.25
	Patient Follow ups	127	59.9%	72	45.0%	0.004*
	Staff Training	76	35.8%	73	45.6%	0.04*
	Marketing Solutions	104	49.1%	67	41.9%	0.17
	None	3	1.4%	4	2.5%	0.45
Do you think any/some of the following fields can be improved with the integration of Artificial Intelligence?	Caries Risk Assessment	93	43.9%	48	30.0%	0.006*
	Growth Prediction	105	49.5%	69	43.1%	0.22
	Assessment of Malocclusion	115	54.2%	70	43.8%	0.04*
	Treatment Prognosis	112	52.8%	75	46.9%	0.26
	None	11	5.2%	20	12.5%	0.01*
Which of the following tasks from your practice do you think can be replaced/ substituted by Artificial intelligence?	Receptionist	137	64.6%	108	67.5%	0.56
	Dental Assistant	96	45.3%	85	53.1%	0.13
	Radiologist	73	34.4%	31	19.4%	0.001*
	Primary Practitioner	29	13.7%	8	5.0%	0.006*
	Consulting Specialist	33	15.6%	20	12.5%	0.40
	Business Administrator	113	53.3%	86	53.8%	0.93
	None	3	1.4%	4	2.5%	0.45
Please select other aspects of daily life where you may be	Travel/Daily commute	137	64.6%	108	67.5%	0.56

International Journal Dental and Medical Sciences Research
Volume 6, Issue 1, Jan-Feb- 2024 pp 122-131 www.ijdmsrjournal.com ISSN: 2582-6018

using AI -	Domestic tasks such as grocery shopping	96	45.3%	85	53.1%	0.13
	Personal Shopping	73	34.4%	31	19.4%	0.001*
	Academic Tasks	29	13.7%	8	5.0%	0.006*
	Finance Management	33	15.6%	20	12.5%	0.40
How open are you to incorporating AI into your dental practice in the future?	Not Likely	14	6.6%	6	3.8%	0.04*
	Less Likely	28	13.3%	32	20.0%	
	Neutral	68	32.2%	44	27.5%	
	Likely	70	33.2%	66	41.3%	
	Very Likely	31	14.7%	12	7.5%	
Please rate your understanding of the legalities involving usage of Artificial Intelligence	Not Sure	56	26.4%	64	40.0%	0.002*
	Slightly unsure	68	32.1%	60	37.5%	
	Neutral	64	30.2%	23	14.4%	
	Sure	15	7.1%	10	6.3%	
	Fully Sure	9	4.2%	3	1.9%	
In your opinion, rate the responsible and ethical use of AI in dentistry?	Unethical	10	4.7%	6	3.8%	0.006*
	Bit unethical	37	17.5%	28	17.5%	
	Neutral	89	42.0%	53	33.1%	
	Partly Ethical	53	25.0%	66	41.3%	
	Ethical & Beneficial	23	10.8%	7	4.4%	
How important is it for you to stay updated on the latest advancements and research related to AI in dentistry?	Not Important	4	1.9%	4	2.5%	0.34
	Less Important	18	8.5%	20	12.5%	
	Neutral	41	19.3%	39	24.4%	
	Important	77	36.3%	55	34.4%	
	Very Important	72	34.0%	42	26.3%	
Would you be interested in attending workshops or training programs focused on AI in dentistry to enhance your understanding and skills?	Yes	114	53.8%	70	43.8%	0.08
	Maybe	89	42.0%	77	48.1%	
	Not Interested	9	4.2%	13	8.1%	

Table 3 Comparison of participants' responses to the study questionnaire based on their years of Practice using Chi Square Test

IV. DISCUSSION

Understanding and accepting artificial intelligence in theory and practice is critical for technological advancement of current and future generations of dentists in India. Therefore, the Knowledge, Attitudes and Practices (KAP) Study on Artificial Intelligence in Dentistry in India is crucial to measure awareness and adoption among dentists. Such a study could shed light on the existing knowledge base, attitudes toward AI implementation, and actual implementation of AI tools in dental clinics.

There have been certain studies done with a similar purpose but a general lack of literature on the various folds of incorporation of AI into dentistry in India has been emphasised by several authors in the past [31] [32] The authors of this survey would like to state that while some topics have been previously researched, there is a lack of detailed research on several topics, to the best of our knowledge.

The findings of this study showed that of the 403 participants,76.2% of the participants were aware of the usage of AI in some form in dentistry which is concurrent with past studies done by

Thulasi et. al. where more than 70% of participants had shown similar awareness [31]. Furthermore, a familiarity with the use of AI in dentistry was seen in 71% of the participants which is higher than that seen in a similar study conducted by Yüzbaşıoğlu et. al. in Turkish population with 67.3% [24]. It was also seen that 54.1% of the participants believed that AI has the potential to improve patient care while 29.8% were neutral on the point. This shows a slight willingness among the participants to accept the differences that man and machine may show. Fair confidence in the accuracy and reliability of AI-based diagnostic systems when compared to traditional methods was seen with 43.4% participants in agreement. In similarity with a study done by Patel et. al. [33], cost of AI technology seemed to be the most agreed upon factor (64.8%) that could delay the incorporation of this technology into the Indian dental arena. This was closely followed by Ethical considerations (63.0%) and lack of training and education on AI for dental professionals (57.8%), posing challenges as previously seen in literature by Akhtar et. al., Paul et. al. among others [34][35][36]. Hence a cost-efficient setup that also has relative ease of adoption and practice would be greatly beneficial to dental artificial intelligence in its infancy in India. It was also seen that the participants with experience of lesser than 5 years believed more firmly that the lack of training and education on the topic being a concern in implementation, in comparison to those with lesser than 5 years of experience. Administrative tasks (56.1%) especially that of a dental receptionist (63.8%) was shown to the most accepted task in a dental practice that could potentially be replaced with Artificial Intelligence. This could be speculated to the current widespread use of virtual assistants such as Alexa, Siri, etc [37]. Participants were also found to agree that Treatment prognosis (51.6%) and assessment of malocclusion (49.1%) would be the most benefited with this technology as also seen in past by Lin L et. al. [38]. Diagnosis and treatment planning although agreed upon to have positive effects on AI incorporation showed a significant difference in agreement on this as those with lesser than 5 years of experience were more accepting of the benefits than the more experienced participants. Similar difference in the agreement of benefits in image analysis and interpretation are also seen. To understand the participants' usage of AI in daily tasks, it was seen that almost all had used it in some form. This shows a general categorisation ability among the majority of the participants for AI usage even through their heedless tasks. The majority of participants (47.7%) were willing to incorporate AI into their daily practice, which is marginally greater than their counterparts in Pakistan (35.1%)[36].A general lack of awareness among participants was seen regarding the legalities that may accompany the usage of AI, 64.1% were unsure to an extent while 24.3% were neutral on the topic much similar to the concerns posed in research by Schönberger D.[39]Disparity was also noted when there was a lower awareness of these legal implications among those with more than 5 years of experience than those with lesser than 5 years of experience. This indicates a greater requirement for awareness on medicolegal aspects on these in the experienced practitioners. However, with a larger number of the participants believing that the use is ethical and beneficial (39.7%), there is a greater rate of ethical acceptance for this. The assent for more awareness and education comes from the 50.9% of participants with interest in attending workshops/training programs focused on AI in dentistry which was lower than previous studies done on a smaller geographic region by Priyadarshini et. al. where it was 89.1% of participating professionals [33] Research for this study also revealed that there may be a need to include the Artificial Intelligence and its application as a part of the academic curriculum given its rise in usage worldwide and potential future in Indian dentistry.[40][41][34][33]

V. CONCLUSION

In conclusion, while awareness of presence of AI in dentistry is widespread, there exists a notable gap in comprehensive understanding regarding its current and future applications, as well as its impact on clinicians' skills and practices. Despite this, the evident enthusiasm among participants to embrace learning and integrate technology into their professional lives is promising. Embracing AI in dentistry aligns with the dynamic nature of technology, offering opportunities for enhanced diagnostics, treatment planning, and patient care. As dental professionals continue to adapt and embrace these advancements, they position themselves to thrive in an ever-evolving technological landscape, ultimately contributing to improved patient outcomes and the overall advancement of dental healthcare.

VI. LIMITATIONS OF THE STUDY

The study was confined to a limited number of participants. Also, selection bias cannot be ruled out because respondents may have been more focused on AI and expressed more positive views than non- participants and each participant may have had a different understanding of AI. Due to the survey being an online questionnaire, the participants may be from areas with better technological reach thereby causing a bias in the data collected. Follow- up surveys and multicentre research should be conducted for further investigation on this topic.

REFERENCES

1. Tandon D, Rajawat J, Banerjee M. Present and future of artificial intelligence in dentistry. Journal of oral biology and craniofacial research. 2020 Oct 1;10(4):391-6.
2. Lewis-Kraus G. The great AI awakening. The New York Times Magazine. 2016 Dec 14;14(12):2016
3. Mörch CM, Atsu S, Cai W, Li X, Madathil SA, Liu X, Mai V, Tamimi F, Dilhac MA, Ducret M. Artificial intelligence and ethics in dentistry: a scoping review. Journal of dental research. 2021 Dec;100(13):1452-60.
4. Khanagar SB, Al-Ehaideb A, Maganur PC, Vishwanathaiah S, Patil S, Baeshen HA, Sarode SC, Bhandi S. Developments, application, and performance of artificial intelligence in dentistry–A systematic review. Journal of dental sciences. 2021 Jan 1;16(1):508-22
5. Asmatahasin M, Pratap KV, Padma TM, Kalyan VS, Kumar VS. Attitude and perception of dental students towards artificial intelligence. Indian Journal of Basic and Applied Medical Research. 2021 Jun;10(3):305-14.
6. Ahmed N, Abbasi MS, Zuberi F, Qamar W, Halim MS, Maqsood A, Alam MK. Artificial intelligence techniques: analysis, application, and outcome in dentistry—a systematic review. BioMed research international. 2021 Jun 22;2021.
7. Lee JH, Kim DH, Jeong SN, Choi SH. Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. Journal of dentistry. 2018 Oct 1;77:106-11.
8. Kuwada C, Ariji Y, Fukuda M, Kise Y, Fujita H, Katsumata A, Ariji E. Deep learning systems for detecting and classifying the presence of impacted supernumerary teeth in the maxillary incisor region on panoramic radiographs. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2020 Oct 1;130(4):464-9.
9. Sur J, Bose S, Khan F, Dewangan D, Sawriya E, Roul A. Knowledge, attitudes, and perceptions regarding the future of artificial intelligence in oral radiology in India: A survey. Imaging Science in Dentistry. 2020 Sep;50(3):193.
10. Devi KJ, Alghamdi W, Divya N, Alkhayyat A, Sayyora A, Sathish T. Artificial Intelligence in Healthcare: Diagnosis, Treatment, and Prediction. InE3S Web of Conferences 2023 (Vol. 399, p. 04043). EDP Sciences.
11. Bouletreau P, Makaremi M, Ibrahim B, Louvrier A, Sigaux N. Artificial intelligence: applications in orthognathic surgery. Journal of stomatology, oral and maxillofacial surgery. 2019 Sep 1;120(4):347-54.
12. Sohmura T, Kusumoto N, Otani T, Yamada S, Wakabayashi K, Yatani H. CAD/CAM fabrication and clinical application of surgical template and bone model in oral implant surgery. Clinical oral implants research. 2009 Jan;20(1):87-93.
13. Hammond P, Davenport JC, Fitzpatrick FJ. Logic-based integrity constraints and the design of dental prostheses. Artificial Intelligence in Medicine. 1993 Oct 1;5(5):431-46.
14. Kikuchi H, Ikeda M, Araki K. Evaluation of a virtual reality simulation system for porcelain fused to metal crown preparation at Tokyo Medical and Dental University. Journal of dental education. 2013 Jun;77(6):782-92.
15. Furman E, Jasinevicius TR, Bissada NF, Victoroff KZ, Skillicorn R, Buchner M. Virtual reality distraction for pain control during periodontal scaling and root planing procedures. The Journal of the American Dental Association. 2009 Dec 1;140(12):1508-16.
16. Bush J. How AI is taking the scut work out of health care. Harv Bus Rev. 2018 https://hbr.org/2018/03/how-ai-is-taking-the-scut-work-out-of-health-care
17. Batra P, Tagra H, Katyal S. Artificial Intelligence in Teledentistry. Discoveries. 2022 Jul;10(3)
18. Aldoseri A, Al-Khalifa KN, Hamouda AM. Re-Thinking Data Strategy and Integration for Artificial Intelligence: Concepts,

Opportunities, and Challenges. Applied Sciences. 2023 Jun 13;13(12):7082.
19. Rokhshad R, Ducret M, Chaurasia A, Karteva T, Radenkovic M, Roganovic J, Hamdan M, Mohammad-Rahimi H, Krois J, Lahoud P, Schwendicke F. Ethical Considerations on Artificial Intelligence in Dentistry: A Framework and Checklist. Journal of Dentistry. 2023 Jun 22:104593.
20. Holzinger A, Langs G, Denk H, Zatloukal K, Müller H. Causability and explainability of artificial intelligence in medicine. Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery. 2019 Jul;9(4):e1312.
21. George AH, George AS. From Pulse to Prescription: Exploring the Rise of AI in Medicine and Its Implications. Partners Universal International Innovation Journal. 2023 Dec 25;1(6):38-54.
22. Srivastava SK. Artificial Intelligence: way forward for India. JISTEM-Journal of Information Systems and Technology Management. 2018 Jul 26;15.
23. Gerke S, Babic B, Evgeniou T, Cohen IG. The need for a system view to regulate artificial intelligence/machine learning-based software as medical device. NPJ digital medicine. 2020 Apr 7;3(1):53.
24. Yüzbaşıoğlu E. Attitudes and perceptions of dental students towards artificial intelligence. Journal of dental education. 2021 Jan;85(1):60-8.
25. Kalyanakrishnan S, Panicker RA, Natarajan S, Rao S. Opportunities and challenges for artificial intelligence in India. In Proceedings of the 2018 AAAI/ACM conference on AI, Ethics, and Society 2018 Dec 27 (pp. 164-170).
26. Baby D, John L, Pia JC, Sreedevi PV, Pattnaik SJ, Varkey A, Gupta S. Role of robotics and artificial intelligence in oral health education. Knowledge, perception and attitude of dentists in India. Journal of Education and Health Promotion. 2023 Nov 1;12(1):384.
27. Rokhshad R, Ducret M, Chaurasia A, Karteva T, Radenkovic M, Roganovic J, Hamdan M, Mohammad-Rahimi H, Krois J, Lahoud P, Schwendicke F. Ethical Considerations on Artificial Intelligence in Dentistry: A Framework and Checklist. Journal of Dentistry. 2023 Jun 22:104593.
28. Schwendicke F, Rossi JG, Göstemeyer G, Elhennawy K, Cantu AG, Gaudin R, Chaurasia A, Gehrung S, Krois J. Cost-effectiveness of artificial intelligence for proximal caries detection. Journal of Dental Research. 2021 Apr;100(4):369-76.
29. KRISHNAPRAKASH G, JODALLI P, SHENOY RP, MOHAMMED IP, AMANNA S. Dentists' Knowledge, Attitude, and Perception Regarding Robotics and Artificial Intelligence in Oral Health and Preventive Dentistry: A Cross-sectional Study. Journal of Clinical & Diagnostic Research. 2023 Jul 1;17(7)
30. Surdilovic D, Abdelaal HM, D'Souza J. Using artificial intelligence in preventive dentistry: A narrative review. Journal of Datta Meghe Institute of Medical Sciences University. 2023 Jan 1;18(1):146-51.
31. Thulasi MS, Sowjanya B, Sreenivasulu K, Kumar MR. Knowledge attitude and practices of dental students and dental practitioners towards artificial intelligence. International Journal of Intelligent Systems and Applications in Engineering. 2022 Oct 15;10(1s):248-53.
32. Singh J, Singh S, Chandra S, Singh D, Mohammad S, Singha J, Chowdhury P, Lodhi N. Longitudinal analysis of artificial intelligence awareness amongst dentists in India: A cross-sectional study. Journal of Dental and Orofacial Research. 2020;16(1):2-8
33. Patel M, Patel C, Bhatt R, Goyal S, Makwani D, Patel F. Transforming Health and Dental Care with Artificial Intelligence: Exploring Opinions from Dentists of Gujarat. Journal of Coastal Life Medicine. 2023 May 29; 11:459-72.
34. Akhtar H, Faheem S, Qasim R, Irfan F, Tanwir A, Hammad H, Hirani S. ASSESSMENT OF KNOWLEDGE AND PERCEPTIONS OF ARTIFICIAL INTELLIGENCE AMONG DENTAL STUDENTS OF KARACHI, PAKISTAN. A MULTI-CENTER SURVEY. Pakistan Oral & Dental Journal. 2022;42(4):193-9.
35. Paul Y, Hickok E, Sinha A, Tiwari U, Mohandas S, Ray S, Bidare PM. Artificial intelligence in the healthcare industry in India. The Centre for Internet and Society, India. 2018.
36. Sajjad IS, Abidi YA, Baig NA, AKHLAK H, LONE MM, AHNED J. Awareness and Perception of Dentists Regarding Role and Future of Artificial Intelligence in Dentistry. Pakistan J Med Heal Sci. 2021;15:3555-8.
37. Drevenstedt GL, McDONALD JC, Drevenstedt LW. The role of voice-activated

technology in today's dental practice. The Journal of the American Dental Association. 2005 Feb 1;136(2):157-61.

38. Lin L, Tang B, Cao L, Yan J, Zhao T, Hua F, He H. The knowledge, experience, and attitude on artificial intelligence-assisted cephalometric analysis: Survey of orthodontists and orthodontic students. American Journal of Orthodontics and Dentofacial Orthopaedics. 2023 Oct 1;164(4):e97-105.
39. Schönberger D. Artificial intelligence in healthcare: a critical analysis of the legal and ethical implications. International Journal of Law and Information Technology. 2019 Jun 1;27(2):171-203.
40. Priyadarshini S, Sharma S, Arish M, Warikoo A, Kalsi R. Determining the Factors Associated with Knowledge and Practice Regarding Artificial Intelligence in Dentistry Among the Dental Professionals of North India. Asian Journal For Convergence In Technology (AJCT) ISSN-2350-1146. 2022 Apr 27;8(1):41-6.
41. Asmatahasin M, Pratap KV, Padma TM, Kalyan VS, Kumar VS. Attitude and perception of dental students towards artificial intelligence. Indian Journal of Basic and Applied Medical Research. 2021 Jun;10(3):305-14.