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Research Article

Knowledge and Perception about Artificial Intelligence (AI) among Dental Practitioners in North India: A Questionnaire Study

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Abstract

Background: Artificial intelligence can be considered development of machines doing tasks associated with human intelligence. Artificial intelligence applications in health care are still being developed, particularly in analysis of images and medical records. Future clinical practice will necessitate that dentists comprehend artificial intelligence technology and be able to adapt to change with re-defined roles.

Aim and Objective: To assess the knowledge and perception about artificial intelligence (AI) among dental practitioners in North India.

Materials and Methods: The survey comprised of 200 dental practitioners. The study was a questionnaire-based survey consisting of 23 questions. It was distributed through Google forms to all the dental practitioners from July 2022 to October 2022. It consists of two sections: part A to record all the demographic data and Part B to know about knowledge and perception towards artificial intelligence and its emerging role in dentistry. The percentage response for each question from all participants was obtained and the data collected was calculated and analysed using Statistical Package for Social Sciences (SPSS) software 21.0.

Results: Out of 200, 168 dentists participated in the study. 71.9% were already aware about AI through internet and social media and 19.2% have attended various conferences and CDEs and are familiar with the artificial intelligence technology. 53.3% believed that AI can be used in diagnosis of the diseases, determining the prognosis and in treatment planning process.

Conclusion: Based on the survey results, a significant number of dentists had knowledge as well as positive attitude in the application of AI for the improvement of dental practice in India.

Keywords: *Artificial Intelligence; Dental Practitioners; Machines; Knowledge; Perception; Technology*

Introduction

Al is not only restricted to sci-fi movies but has started spreading its wings to almost all horizons of the industries. This technology is working towards providing an enhanced and a more personalized experience to users. Their focus has now shifted towards providing tailored or hyper-personalized customer experience through the usage of Artificial Intelligence, machine learning, and big data. As a re-

sult, Food and Drug Administration (FDA) provides regulatory channels to encourage development of medical decision support software, analytical project for the usage of artificial intelligence in healthcare that will increase by a factor of ten over the next decade [1].

The term "artificial intelligence" was first coined by John McCarthy. He first described it as "the science and engineering of making intelligent machines". He is considered as the Father of artificial intelligence [1]. Artificial intelligence is not one technology, but rather a collection of them [2]. The examples of artificial intelligence are Siri, Alexa and other smart assistants, Self-driving cars, Robo-advisors, Conversational bots, Email spam filters, Netflix's recommendations etc [2]. Artificial intelligence "is utilised when a machine imitates "cognitive" processes, including "learning" and "problem-solving," that humans associate with other human minds [3].

Various definitions have been given in the literature by researchers [4]:

- Artificial intelligence: Create systems to perform functions requiring human intelligence.
- Machine learning: Subfield of artificial intelligence; computers perform functions by learning patterns rather than being programmed.
- Deep learning and artificial neural network: Type of machine learning; Uses many layers of data, some are hidden.
- Convolutional neural network: Subfield of deep learning; Uses an operation with application in image analysis.

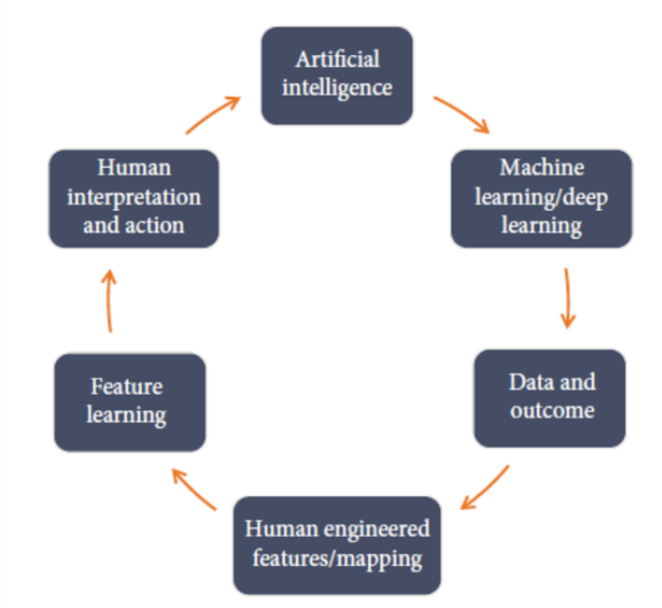


Figure 1: *Schematic illustration of artificial intelligence model [5].*

AI is revolutionising in every field of medical, dental as well as in industry. It can do a variety of activities in a day-to-day practice of dentistry with more precision and efficacy with reduced no. of staff and negligible errors than human counterparts. This technology even works for scheduling and arranging regular appointments for the patients and also assisting with clinical diagnosis and treatment planning of the patients. This advanced technology can automatically detect and classify dental restorations on panoramic radiographs

(OPG) and aid in the detection of dental and maxillofacial abnormalities such as periodontal diseases, root caries, bony lesions, e.g. BRONJ (bisphosphonate-related osteonecrosis of the jaw) associated with dental extraction, and maxillofacial defects.

AI has also been demonstrated to be beneficial in restorative dentistry. This skilful technology has the potential to determine the most appropriate restorative material for the long-term restoration of dental caries after gathering diverse data radiographically and from other sources. A convolutional neural network (CNN) approach based on deep learning performed exceptionally well in detecting dental cavities in intra-oral periapical radiographs. On panoramic radiographs, it also assisted in detecting and classifying impacted supernumerary teeth in patients with fully erupted maxillary permanent incisors. In addition to this, it was utilised to identify the periapical lesions on panoramic radiographs. Artificial neural networks (ANNs) could serve as a second opinion to identify the apical foreman on radiographs and improve the accuracy of working length determination during root canal treatment by IOPA. Based on the host immune response of the patient, ANN could also be helpful in categorizing the aggressive and chronic periodontitis patients. This technique gives an accurate diagnosis of both aggressive and chronic periodontitis patients through simple and convenient parameters obtained from patient's blood. This advanced technology (CNN) also assists in classifying different types of dental arches and obtaining RPDs through this technology is more convenient with software application. The impact of orthognathic treatment on facial beauty and age appearance can be analysed by artificial intelligence.

It can assist in coordinating regular appointments and alerts the dentists as well as the patients about check-ups whenever there is increased susceptibility of diseases due to personal habits and lifestyle of the individuals (e.g. periodontal screening for patients with diabetes and oral cancer screening for those who habitually use smoked or smokeless tobacco) [1]. Using cone beam computed tomography (CBCT) has also resulted in tremendous success in the development of algorithms tailored to orthodontic analysis in patients with craniofacial abnormalities. Algorithms with a weighed tooth-extraction/non-extraction decisions in orthodontic treatment also demonstrate excellent performance, with 90.4% agreement between the optimised model's recommendations and the actual treatment administered in the patients.

Various dental institutes and dental schools are going to utilise this type of advanced technology. The primary goal is to achieve hands-on learning in the clinic through scanning by 3D intraoral scanners. Therefore, through this technology dental students will have more effective and objective learning to provide the best care for their patients. With the recent incorporation of artificial intelligence in intelligent tutoring systems such as in the unified medical language system (UMLS); there is a huge improvement in the quality of feedback. However, there is limited published information and data regarding the knowledge, awareness, and attitude of dentists regarding artificial intelligence.

Hence, the present study was conducted to assess the knowledge and perception about artificial intelligence (AI) among dental practitioners in North India.

Materials and Methods

The present questionnaire-based survey was conducted among 200 dental practitioners who responded to the online questionnaire which was sent through one social media (WhatsApp/Gmail) site.

The time period for completion of the survey was 3 months and was conducted from August 2022 to October 2022. The format of the questionnaire performa was in English language. A verbal consent was obtained from all the participants before the start of the study.

The questionnaire was circulated through Google Forms to all the dental practitioners either working in multispecialty hospitals or having their own private practice as well as to all the postgraduate students of different dental departments.

Questionnaire design

The data of the survey was collected through a structured interview in the form of a questionnaire. The questionnaire composed of 23 closed ended questions categorized into two sections: (a) Socio-demographic data that includes age, gender and designation of dental practitioners, (b) Knowledge, awareness and attitude regarding artificial intelligence that includes the questions regarding the knowledge about the artificial intelligence, their applications in various field of dentistry as well as the knowledge of advanced technology as a diagnostic and prognostic tool. The questions regarding attitude of dental practitioners were based on the use of advanced technology in dental office having various advantages and limitations and their significant role in dentistry especially in India in future.

The questionnaire survey was uploaded through google forms and sent via social media to all the dental practitioners who are either working in multispeciality hospital or having their own private practice.

The participants filled questionnaire survey through google forms. All the date was collected and evaluated for statistical analysis.

Statistical analysis

The filled responses were then transferred to the microsoft excel sheet for appropriate statistical analysis. The percentage response for each question from all participants was obtained and the data was calculated and analysed using Statistical Package for Social Sciences (SPSS) software 21.0.

Results

Out of 200 patients, 168 participants responded positively in this study by submitting the questionnaire. In this way the response rate was 84%. Rest of the participants didn't complete the questionnaire and incomplete data was excluded from the survey.

Socio-demographic features of study participants (Table 1)

The socio-demographic variables of study participants included age, gender and designation which are depicted in table 1. Out of 168 participants, 153 (91.9%) of them belonged to age group of 20 - 30 years, and 11 (6.5%) participants belonged to 31-50 years of age group. Only 4 participants (2.4%) were more than 50 years of age group.

There were more female participants, 127 (75.6%) as compared to male participants which were only 41 (24.4%). Based on designation criteria, majority of the participants belonged to group as post-graduate students (48.8%) which is followed by private practitioners and dental surgeons who are working in hospitals with a percentage of 29.2% and 22% respectively.

Variables		Subjects (n)	Percentage (%)
Age	20-30 yrs.	153	91.1%
	31-50 yrs.	11	6.5%
	>50 yrs.	4	2.4%
Gender	Male	41	24.4%
	Female	127	75.6%
Designation	PG Student	82	48.8%
	Private Practitioner	49	29.2%
	Dental Surgeon in Hospital	37	22%

Table 1: *Distribution of the study population according to socio demographic variables (n = 168).*

Knowledge and awareness regarding artificial intelligence of study participants (Table 2)

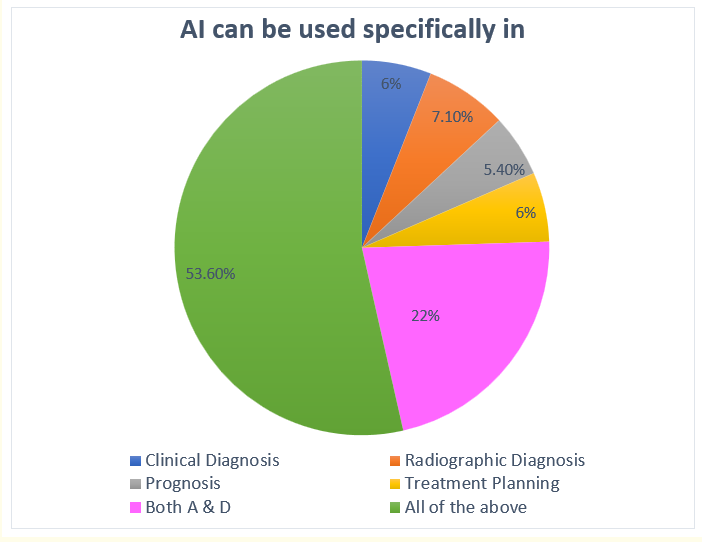
Knowledge and awareness regarding artificial intelligence of study participants are depicted in table 2. Majority (89.3%) of them were aware of the term artificial intelligence and only 30.4% completely understand the term artificial intelligence. However, most of them (64.9%) partially understood the term artificial intelligence. When asked about the source of knowledge regarding artificial intelligence, 72 stated social media/internet, 19% stated conferences/ CDE program and 4.8% stated TV and newspaper. Most of the participants (67.9%) were aware of the usage/application of artificial intelligence in dentistry (67.9%- agreed and 16.1%- disagreed). 59.5% of participants believed that artificial intelligence would lead to an advanced innovation in dentistry.

22% of the participants positively responded that artificial intelligence can be used for clinical diagnosis and treatment planning. However, 53.6% believed that artificial intelligence can be used for clinical and radiographic diagnosis as well as for prognosis and treatment planning (Pie chart 1). 66.1% participants believed that artificial intelligence can be used as a 'prognostic tool' to predict the course of disease and to determine the chance of recovery (Pie chart 2). It was widely agreed (78.6%) by participants that artificial intelligence can be used for radiographic diagnosis of tooth decay and periodontal diseases, diagnosis of soft tissue lesion (64.3%), radiographic diagnosis of pathologies of the jaw (76.2%) and 3D implant positioning (81.5%).

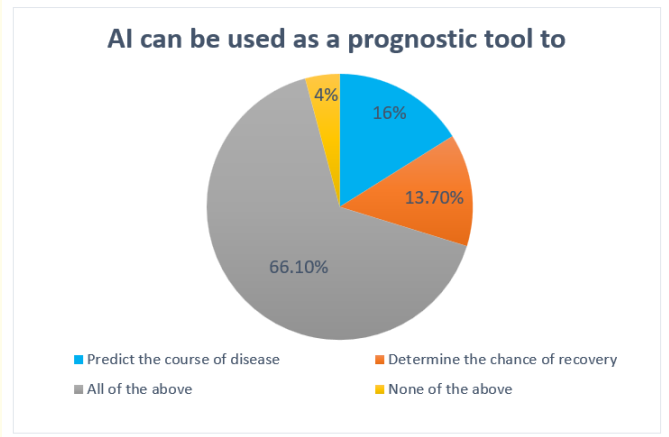
Questionnaire	Response	Subjects (N)	Percentage (%Age)
Do you understand the term Artificial Intelligence (AI)?	Yes	150	89.3
	No	9	5.4
	Can't Say	9	5.4
Where have you come across the term AI?	Television	8	4.8
	Internet/social media	121	72
	Newspapers	7	4.2
	Conference/CDE Program	32	19
How well do you understand artificial intelligence?	Completely Understand	51	30.4
	Partially Understand	109	64.9
	No Knowledge	8	4.8
Are you familiar with the use/ application of artificial intelligence in dentistry?	Strongly Agree	25	14.9
	Agree	114	67.9
	Disagree	27	16.1
	Strongly Disagree	2	1.2
Do you believe AI could lead to innovations in dentistry?	Strongly Agree	57	33.9
	Agree	100	59.5
	Disagree	10	6
	Strongly Disagree	1	0.6
Where in dentistry can AI be used specifically?	Clinical Diagnosis	10	6
	Radiographic diagnosis	12	7.1
	Prognosis	9	5.4
	Treatment planning	10	6
	Both A and D	37	22
	All of the above	90	53.6

AI can be used as a prognostic tool to	Predict the course of disease	27	16.1
	Determine the chance of recovery	23	13.7
	All of the above	111	66.1
	None of the above	7	4.2
AI can be used for	Radiographic Diagnosis of tooth decay	15	8.9
	Radiographic Diagnosis of periodontal disease	17	10.1
	Both A and B	132	78.6
	None of the above	4	2.4
Can AI be used for the diagnosis of soft tissue lesions?	Yes	108	64.3
	No	12	7.1
	No idea	48	28.6
Can AI be used for the radiographic diagnosis of pathologies of the jaw?	Yes	128	76.2
	No	11	6.5
	No Idea	29	17.3
Can AI be used for 3-Dimensional positioning of implants?	Yes	137	81.5
	No	10	6
	No Idea	21	12.5

Table 2: *Survey questions on knowledge and awareness regarding artificial intelligence of study participants (% of positive response).*



Pie Chart 1



Pie Chart 2

Attitude of study participants regarding artificial intelligence (Table 3)

Attitude of study participants regarding the advanced technology i.e. artificial intelligence are depicted in table 3. The response of participants for most of the questions based on the artificial intelligence were positive. Majority (65.6%) of the participants agreed that artificial intelligence can be used to assess and evaluate the efficacy of the treatment and may act as an additional aid for dentist while making clinical diagnosis. However, regarding the diagnostic opinion only 12.5% participants would choose artificial intelligence as an opinion and 48.8% participants would choose their own diagnostic opinion.

As artificial intelligence is an innovative technology and it has certain advantages when asked the participants regarding the advantages of artificial intelligence. Majority (53.6%) were believed that artificial intelligence is less time consuming (14.9%), reduces the risk of human errors (21.4%), serves better to ergonomics (6%) and is more clinically relevant (4.2%) (Pie chart 3). This innovative technology also has certain limitations. Majority (35.7%) believed that artificial intelligence is expensive, 23.8% agreed that dentists can be more dependent on this technology and 10.7% believed that it is difficult to operate (Pie chart 4). Majority (83.9%) responded that they would be willing to study artificial intelligence. Regarding the means awareness for learning artificial intelligence, 42.3% participants positively want to do hands-on way of learning, 30.4% wants to do online mode of learning, 23.2% participants were interested in short courses and only 4.3% were interested in attending one day CDE programs (Pie chart 5).

Because of this advanced innovate technology, most of them (58.9%) agreed that artificial intelligence would lead to fewer human-human interactions. Regarding future of artificial intelligence in India, 70.8% participants agreed that artificial intelligence would play a significant role in dentistry especially in India in future. 70.8% participants positively agreed that patients will accept artificial intelligence for their diagnostic, prognostic and treatment planning.

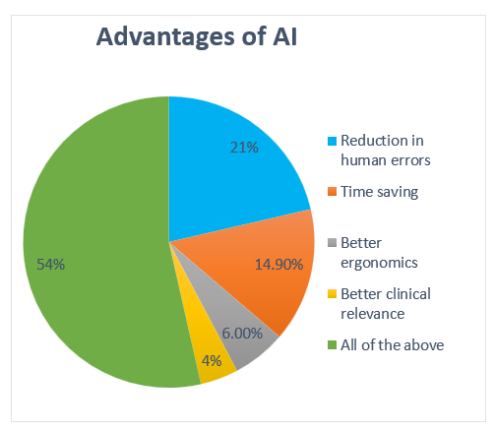
Discussion

Modern dentistry is based on a new kind of technology where the patient information is shared in a digital software. This may range from patient registration information along with demographic analysis to the diagnostic, prognostic and treatment planning data. Artificial intelligence is a new innovative technology that has been used in various disciplines of dentistry. It is a branch of computer science

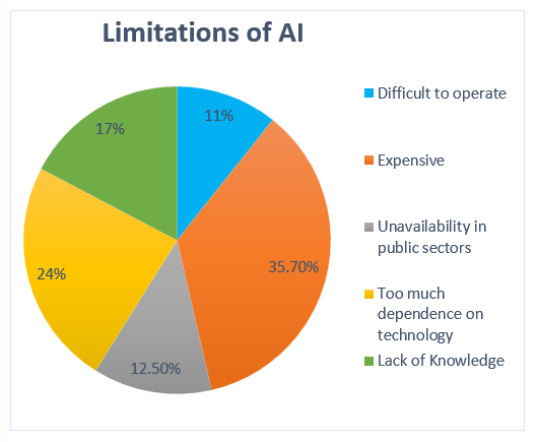
Questionnaire	Response	Subjects (n)	Percentage (%)
Can AI be used to assess and evaluate the efficacy of a treatment?	Strongly Agree	45	26.8
	Agree	110	65.5
	Disagree	13	7.7
	Strongly Disagree	0	0
Do you believe artificial intelligence act as an additional aid for dentists in making clinical diagnosis?	Strongly Agree	43	25.6
	Agree	115	68.5
	Disagree	10	6
	Strongly Disagree	0	0
What will you choose if your diagnostic opinion differs from that of AI?	My opinion	82	48.8
	AI's opinion	21	12.5
	Can't say	65	38.7
Would you use artificial intelligence in your dental office?	Yes	79	47
	No	12	7.1
	Maybe	68	40.5
	Can't Say	9	5.4
What advantages does AI possess in your opinion?	Reduction in human errors	36	21.4
	Time saving	25	14.9
	Better ergonomics	10	6
	Better clinical relevance	7	4.2
	All of the above	90	53.6
What could be the limitations of AI?	Difficult to operate	18	10.7
	Expensive	60	35.7
	Unavailability in public sectors	21	12.5
	Too much dependence on technology	40	23.8
	Lack of Knowledge	29	17.3
Which dental groups need to be informed about AI?	Undergraduate Students and Post-Graduates	28	16.7
	Private Practitioners and Dental Surgeons	19	11.3
	All of the above	121	72
Will you be willing to study AI?	Yes	141	83.9
	No	8	4.8
	Can't Say	19	11.3
What mode of awareness does you prefer to learn AI?	Online mode	51	30.4
	Hands-On	71	42.3
	Short courses	39	23.2
	One Day CDE programs	7	4.2
Do you think AI will lead to fewer human-human interactions?	Strongly Agree	29	17.3
	Agree	99	58.9
	Disagree	38	22.6
	Strongly Disagree	2	1.2

Do you believe that artificial intelligence will play a significant role in dental care in India in future?	Strongly Agree	35	20.8
	Agree	119	70.8
	Disagree	13	7.7
	Strongly Disagree	1	0.6
Do you anticipate that patients will accept AI?	Strongly Agree	27	16.1
	Agree	119	70.8
	Disagree	18	10.7
	Strongly Disagree	4	2.4

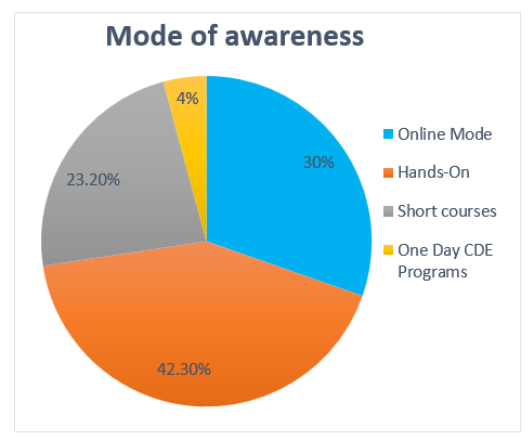
Table 3: *Survey questions on attitude of study participants regarding artificial intelligence.*



Pie Chart 3



Pie Chart 4



Pie Chart 5

mainly concerned with smart software and machines that are capable of performing all the tasks that typically requires human intelligence. The main function of AI in dentistry includes assisted treatment plan, computer aided diagnosis based on medical image and productive data and analysis.

This newer technology is based on various types of neural network that include artificial neural network and convolutional neural network. The advantages of this technology are better efficiency and monitoring more accuracy and precision as well as time saving. Therefore, this survey was conducted among dental practitioners to assess the knowledge and perception about artificial intelligence.

In this survey, majority of respondents rated their knowledge as excellent (89.3%) on this technology. However, 30.4% and 64.9% response were based on complete understanding and partial understanding of AI respectively. This may show that the frequent use of AI in daily practice of detecting is a key factor for adequate knowledge in this area. However, the study conducted by Oh., *et al*. in 2019 claimed that only 5.9% respondents were familiar with AI [6]. Dental practitioners also stated that internet/social media is the main mode of information that TV/newspapers/CDE programs or conferences. The results are in accordance with Fotea and Tundrea., *et al*. in 2019 [7].

Diagnosis in dentistry is one of the primary concerns based on clinical and radiographic features and whole of the treatment of patient is only based on the diagnostic criteria. Majority of dental practitioners agreed that AI is specifically used in clinical and radiographic diagnosis along with treatment plan. 78.6% stated that it is used in radiographic diagnosis of tooth decay and periodontal diseases. Pakdemirli E (2019) concluded that AI has been a source of great innovation in technology and an advanced topic of discussion among radiologists and ground-breaking research in recent years [8]. AI has the potential to allow the radiologists to perform value added tasks and play a primary role to work as a multidisciplinary clinical team [9]. AI has also used as a prognostic tool which predict the course of the disease and determine the chance of recovery and majority (66.1%) of dental practitioners agreed with it.

In the present survey, only 12.5% dental practitioners agreed that Artificial Intelligence can be used as a second diagnostic opinion and the results are in contrast with the study conducted by Mupparapu., *et al*. in 2018 [10]. Mupparapu., *et al*. stated that dentists could benefit from this innovative technology as a second opinion within nanoseconds using AI technologies that have the potential to provide correct diagnosis and eventually help the dental practitioners to make right treatment for the patients.

Artificial intelligence has a revolutionized technology in the field of dentistry having many advantages including reduction in human error, better ergonomics and clinical relevance and it is time saving and majority (53.6%) of dental practitioners agreed with this. However, 35.7% dental practitioners also responded that Artificial Intelligence technology is expansive in clinical dental practice. Even 17.3% dental practitioners also responded that there is a lack of knowledge among dentists and not using this technology in day-to-day practice. In the present survey 42.3% dental practitioners strongly agreed to learn AI based on hands on courses as compared to online mode or one day CDE programmes. This might be because of AI is a new technology and it might be challenging for dental practitioners to implement in daily routine practice. This can be attributed to the complexity of the technical system and the variety of applications and operational methods of artificial intelligence [11]. Similar results are found in the study conducted by Aboalshamat KT in 2022 in Saudi Arabia [12]. Therefore, it might be useful for courses and topics discussing AI to be provided in a more hands-on session to make AI and its uses more familiar for dental professionals.

Nevertheless, digital literacy will become a necessity with the world's advancement and global technological movement. This is augmented by Saudi Arabia's Vision 2030, which includes a digital transformation for the country as one of its main initiatives [13]. In the present survey 70.8% dental practitioners agreed that AI will play a significant role in dentistry in India in future. Most of the results from the previous literature are more or less similar to the result of this survey. Although scientific studies and surveys are going on, the results of this survey showed that majority of dental practitioners have an interest towards learning about AI and its potential future applications as a new technology. This survey also has certain limitations included the use of self-reported questionnaire design, participants included only from the north region and the use of online google form to collect the data for survey.

Conclusion

The results of this survey concluded that majority of dental practitioners have a sound level of knowledge and positive attitude towards the use of artificial intelligence in dentistry. Although, this is an advanced technology, still there is a need to receive detailed knowledge in dental education to both undergraduate and post-graduate students and also provide more lectures along with hands-on courses of CDE programmes in order to have a better understanding of artificial intelligence.

With its promising potential opportunities, it can assist in the analysis of complex radiographic scans, improve diagnostic precision, minimize errors, and potentially lead to the more precise and reliable detection of various maxillofacial disorders.

In future, more clinical studies and surveys are needed to put this AI technology to day-to-day practice and digitalize the work of dental practitioners.

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