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A questionnaire study regarding knowledge, attitude and usage of artificial intelligence and machine learning by the orthodontic fraternity of Northern India

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ABSTRACT

Aim: The aim of the questionnaire study was to determine the knowledge, attitude, and perception of orthodontists regarding the role of artificial intelligence in dentistry in general and orthodontics specifically, and to determine the use of artificial intelligence by the orthodontist.

Methods: This cross-sectional study was done among the orthodontists of Northern India (clinicians, academicians, and postgraduates) through a web-based electronic survey using Google Forms. The study was designed to obtain information about AI and its basic usage in daily life, in dentistry, and in orthodontics from the participants. The options given were set specifically according to the Likert scale to maintain the correct format. The questionnaire was validated by one AI expert and one orthodontic expert, followed by pretesting in a smaller group of 25 orthodontists 2 weeks before circulation. A total of 100 orthodontists and postgraduate students responded to the pretested online questionnaire link for 31 questions in four sections sent via social media websites in a period of 3 months.

Results: The majority of the participants believe that AI could be useful in diagnosis and treatment planning and could revolutionize dentistry in general. 84 % of the orthodontic academicians and clinicians, including PG students, consider AI a useful tool for boosting performance and delivering quality care in orthodontics, and 72 % see AI as a partner rather than a competitor in the foreseeable future of dentistry. 90 % of the participants believe that the incorporation of AI into CBCT analysis can be a valuable addition to diagnosis and treatment planning. 86 % of total participants agree that AI can be helpful in decision-making for orthognathic surgery, and 84 % find AI useful for bone age assessment.

Conclusions: It was observed that academicians are more aware of AI terminologies and usage as compared to PG students and clinicians. There is a consensus that AI is a useful tool for diagnosis and treatment planning, boosting performance and quality care in orthodontics. In spite of these facts, 62.5 % of clinicians and 40 % of PG students are still not using AI for cephalometric analysis ($p = 0.033$).

1. Introduction

The human brain is considered to be the most unique and fascinating thing to be observed and is being studied extensively. Humans are considered the most efficient and intelligent of all the existing species on the planet, making them distinguished and preeminent. The need to use technology so that we can imitate human intelligence dates back to the

1950s. Artificial intelligence is considered one such example of recent technological evolution. AI is simply a machine, especially a computer, mimicking the human brain or simulating human intelligence.¹ The use of AI has grown exponentially in our daily lives. We use Google's intelligence search, personal voice recognition software, chat bots for instant service management, and city mapping tools to help us travel with ease and comfort. Paradoxically, a lot of people are unaware of its

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presence in most of the routine things that they are doing.²

The application of AI in healthcare has gained a lot of attention all over the globe. Computer-based diagnosis is gaining momentum due to its ability to detect and diagnose lesions that can go unnoticed by the human eye, hence paving way for new holistic practices. The AI-based applications are thought to bring about a lot of changes for the betterment of the health care systems, along with more efficient and improved patient care. The potential value of AI in healthcare varies from booking an appointment with the help of virtual assistance to diagnosis and treatment planning, improving quality and efficiency of care and delivering personalized and precise results. AI can be included in every aspect of health.³ AI can help reduce variability in care while improving precision, accelerating discovery, and reducing disparities. AI can empower patients and also allow healthcare professionals to relate to their patients as healers with the mutual support of the combined wisdom of the best medical research and analytic technology.⁴

AI in dentistry is still in its initial phase and is yet to reach final coverage with its full potential. The basic uses of AI in dentistry start from active patient monitoring, reducing the time spent on records, to the detection of caries, alveolar bone loss, color selection, removable partial denture design, temporomandibular disorders, tooth localization in periapical x-ray images through the convolution neural network, segmentation of gingival diseases through oral images, diagnosing periapical pathosis, including oral cancers and cystic lesions, facial analysis, and computer-aided designing and manufacturing (CAD/CAM) veneers, crowns/bridges.^{5,6} There is a high chance that future systems will be more efficient and will perform tasks like patient trials and screening independently with precision.

AI technology has been applied in orthodontics for cephalometric landmark identification, determining the degree of maturation of the cervical vertebrae, need for orthodontic extractions, predicting the facial attractiveness post orthognathic surgery, predicting orthodontic treatment needs and treatment planning. Most of these artificial intelligence models are based on either artificial neural networks (ANNs) or convolutional neural networks (CNNs).⁷ It is known that orthodontic treatments are long and have an average duration of 10–29 months; orthodontists can thus use machine learning techniques for treatment monitoring as well. The use of tele-orthodontics like Dental Monitoring® (Dental Monitoring Co., Paris, France)⁸ is a breakthrough in the monitoring of patients remotely undergoing orthodontic treatment with clear aligners.⁹ During the COVID-19 pandemic it allowed the scope to monitor patients remotely during lockdowns, reduced the costs, limited direct contact when was not necessary¹⁰ and thus decreased the risk of COVID-19 dissemination.¹¹

Recent advancements in orthodontics include cone beam computed tomography and 3D visualizations, the use of facial scanners, intraoral scanners for instant tooth modeling, 3D printing, and the use of robotics.² The world as we know is changing on a daily basis; every day is different from yesterday, and a lot of scope of improvement is there for tomorrow. Although the literature has many research papers assessing the knowledge and perception of medical and dental students and practitioners towards AI usage, nothing specific pertains to the field of orthodontics. Thus, the current research was done to assess the knowledge, attitude, and perception of orthodontists (clinicians, academicians, and postgraduates) towards the use of artificial intelligence in dentistry and in the field of orthodontics.

2. Aim

1. To determine the *knowledge, attitude, and perception* of orthodontists regarding the role of artificial intelligence in dentistry in general and orthodontics in particular.
2. To determine the *usage* of artificial intelligence by orthodontist in their specialty.

3. Materials and methods

A cross-sectional study was done among the post graduate students and academicians from the Post Graduate Department of Orthodontics of Dental Council of India recognized dental colleges in Northern India and Indian orthodontic society endorsed MDS orthodontic clinicians practicing in Northern India. A web-based electronic survey using Google Forms was designed to obtain the information they have about AI, its basic usage in daily life, and its use in dentistry and orthodontics. The options given were set specifically according to the Likert scale to maintain the correct format. For clarity of the questions, the questionnaire was validated by one AI expert and one orthodontic expert, followed by pretesting in a smaller group of 25 orthodontists 2 weeks prior to the circulation. After the analysis of the data, Cronbach's was calculated to assess and define the internal consistency of the survey tool.

Sample size calculation was performed with command as observational designs (cross-sectional study) in the Open Epi, Version 3, open source calculator. Two-sided significance level (1-alpha) was fixed at 95 %. Power (1-beta, % chance of detecting) was set as 80 %. Allowable error was taken as 5 %. Prevalence of knowledge of AI was taken as 94.13 %¹² and thus reference sample size came out as 88 study subjects. Assuming a non-response rate of 10 %, sample size was computed to be 96. Thus, as a round figure, final sample size taken up for this study was 100. Orthodontists (clinicians and academicians) and postgraduate students responded to the pretested online questionnaire link shared via various social media platforms for 31 questions in four sections during a span of 3 months. The first section of the survey had eight questions based on socio-demographic characteristics such as name, age, gender, profile, years in practice, college or clinic name, and year of study (for postgraduate students). The second section had seven questions based on basic knowledge about artificial intelligence. The third section had eight questions based on the attitude of orthodontists towards artificial intelligence in dentistry. The fourth section had eight questions based on the usage of artificial intelligence by orthodontists in the field of orthodontics. Participants were asked to select one answer from the options given for each question, as per the Likert scale. To ensure anonymity, no tracking system was used. This data was then compiled in tabular form in excel sheets. Sections 3 and 4 of the questionnaire (attitude and usage of AI) were subjected to factor analysis to extract the maximum common variance from these sections and put them into five factors for further analysis. Ethical clearance has been obtained from Institutional Ethical Committee (letter no: IEC/GDC/85/2024).

4. Statistical analysis

The data was analyzed using IBM SPSS Statistics, version 25, predictive analytics software. The chi-square test and Fisher's exact test were used to find the significance of study parameters on a categorical scale between two or more groups. Factor analysis and the KMO Bartley test were used to extract a sufficient number of factors appropriate for the study. When p values were <0.05 at a 95 % confidence interval (CI), statistical significance was considered.

5. Results

During the study period, 50 orthodontists (academicians and clinicians) and 50 postgraduate students (first year 34.6 %, second year 34.6 %, and third year 30.8 % of MDS Orthodontics) completed the survey. 50 % of the participants (n = 50) were male and 50 % were female (n =

Table 1
Demographics.

	Academician	Clinician	Postgraduate Student
Age (In years)	42.18 ± 7.56	40.88 ± 10.97	29.72 ± 5.25

50). The mean age of the sample is shown in Table 1. Academicians have been working in the field of orthodontics with an average experience of 11.5 ± 8.14 years and clinicians with 9.44 ± 9.31 years. Postgraduate students have limited experience in the field of orthodontics, but being the younger generation, they were considered to be more tech-savvy in the usage of AI.

For comparisons, the participants were divided into three groups: academicians, clinicians, and postgraduate students. The level of awareness about artificial intelligence amongst them is shown in Table 2. Regarding the use of AI in daily life, 41.2 % of academicians are extremely aware, followed by PG students (20 %) and clinicians (12.5 %) (p = 0.002). 100 % of the academicians are aware of AI-based phone and computer applications, whereas only 75 % of postgraduates and 50 % of clinicians are aware of the same (p = 0.000). 91.8 % of participants know the definition of artificial intelligence, with web browsing and social media as major sources of information (63 %). 82.4 % of academicians are somewhat aware of terminologies like machine learning and deep learning, whereas 25 % of clinicians are not at all aware (p = 0.002). Less human interaction with the patient is the concern of 60 % of the participants for AI usage, followed by hacking and cyber security (24 %).

Regarding attitude towards AI in dentistry and usage in orthodontics, sections 3 and 4 of the questionnaire were subjected to factor analysis to extract the maximum common variance. Five factors were identified for further analysis (Table 3).

- Factor 1: Attitude towards AI usage
- Factor 2: Recommending AI to a fellow practitioner
- Factor 3: AI as a partner in dentistry
- Factor 4: Utility of AI in Orthodontics
- Factor 5: Current Usage of AI for Cephalometric Analysis

Table 4 shows the responses of academicians, clinicians, and

postgraduate students regarding attitudes toward AI and its usage in orthodontics, with significance levels indicated for p-values that are lower than 0.05.

5.1. Factor 1: Attitude towards AI usage

75 % of the clinicians somewhat agree to consider AI as a quality control tool to evaluate treatment success, followed by academicians (70.6 %) (p = 0.004). 82 % of the participants believe that AI could be useful in diagnosis and treatment planning and can revolutionize dentistry (78 %). This view is somewhat or strongly held.

5.2. Factor 2: Recommending AI to fellow practitioners

A total of 76 % of the participants agreed that AI should be recommended to fellow practitioners, with 6 % disagreeing.

5.3. Factor 3: AI as a partner in dentistry

84 % of the orthodontic academicians and clinicians, including PG students, consider AI a useful tool for boosting performance and delivering quality care in orthodontics, and 72 % see AI as a partner rather than a competitor in the foreseeable future of dentistry.

5.4. Factor 4: Utility of AI in orthodontics

90 % of the participants believe that the incorporation of AI into CBCT analysis can be a valuable addition to diagnosis and treatment planning. Post-treatment smile prediction software like "Smile View" by Invisalign can increase patients acceptance of taking up orthodontic treatment, which is somewhat agreeable to 60 % of the postgraduate students (p = 0.012), whereas 50 % of the clinicians strongly agree with this statement. 86 % of total participants agree that AI can be helpful in

Table 2
Participants basic knowledge about Artificial Intelligence.

Question	Academician	Clinician	Postgraduate Student	Total	P-value
1. How aware are you about the use of AI in daily life (like speech recognition, text recognition, email spam filters)?					
Extremely aware	14 (41.2 %)	2 (12.5 %)	10 (20.0 %)	26 (26.0 %)	0.002*
Somewhat aware	18 (52.9 %)	10 (62.5 %)	30 (60.0 %)	58 (58.0 %)	
Not so aware	2 (5.9 %)	0 (0.0 %)	8 (16.0 %)	10 (10.0 %)	
Not at all aware	0 (0.0 %)	4 (25.0 %)	2 (4.0 %)	6 (6.0 %)	
2. Which of the following is an AI app ?					
Alexa	0 (0.0 %)	4 (25.0 %)	8 (16.0 %)	12 (12.0 %)	0.000*
Siri	0 (0.0 %)	4 (25.0 %)	0 (0.0 %)	4 (4.0 %)	
Cortona	0 (0.0 %)	0 (0.0 %)	4 (8.0 %)	4 (4.0 %)	
All	34 (100.0 %)	8 (50.0 %)	38 (76.0 %)	80 (80.0 %)	
3. What according to you is Artificial intelligence					
Branch of science dealing with algorithms to simulate human intelligence	32 (94.1 %)	14 (87.5 %)	46 (92.0 %)	92 (92.0 %)	0.723
Computer programming language	2 (5.9 %)	2 (12.5 %)	4 (8.0 %)	8 (8.0 %)	
4. Do you have basic understanding of Artificial intelligence terminologies like machine learning, deep learning?					
Extremely aware	2 (5.9 %)	0 (0.0 %)	2 (4.0 %)	4 (4.0 %)	0.002*
Somewhat aware	28 (82.4 %)	10 (62.5 %)	28 (56.0 %)	66 (66.0 %)	
Not so aware	4 (11.8 %)	2 (12.5 %)	18 (36.0 %)	24 (24.0 %)	
Not at all aware	0 (0.0 %)	4 (25.0 %)	2 (4.0 %)	6 (6.0 %)	
5. What is machine learning ?					
A subset of AI where computer program learns automatically from experience	21 (61.8 %)	10 (62.5 %)	34 (68.0 %)	65 (65.0 %)	0.149
A subset of deep learning to solve complex problems	9 (26.5 %)	0 (0.0 %)	8 (16.0 %)	17 (17.0 %)	
AI is synonymous with machine learning	2 (5.9 %)	4 (25.0 %)	6 (12.0 %)	12 (12.0 %)	
None of the Above	2 (5.9 %)	2 (12.5 %)	2 (4.0 %)	6 (6.0 %)	
6. How did you get to know about AI?					
Conferences	4 (11.8 %)	4 (25.0 %)	12 (24.0 %)	20 (20.0 %)	0.120
Lectures in university	1 (2.9 %)	0 (0.0 %)	6 (12.0 %)	7 (7.0 %)	
Newspaper and magazines	6 (17.6 %)	0 (0.0 %)	4 (8.0 %)	10 (10.0 %)	
Web browsing and Social media	23 (67.6 %)	12 (75.0 %)	28 (56.0 %)	63 (63.0 %)	
7. What are your concerns of use of AI?					
Data privacy	4 (11.8 %)	0 (0.0 %)	6 (12.0 %)	10 (10.0 %)	0.497
Fear of job replacement	2 (5.9 %)	0 (0.0 %)	4 (8.0 %)	6 (6.0 %)	
Hacking and cyber security attacks	6 (17.6 %)	4 (25.0 %)	14 (28.0 %)	24 (24.0 %)	
Less human interaction with the patient	22 (64.7 %)	12 (75.0 %)	26 (52.0 %)	60 (60.0 %)	

Table 3
Factor analysis.

	1	2	3	4	5
AI can be used as a quality control system to evaluate the treatment results/success	.803	.208	.113	.151	
AI can be used as a tool for diagnosis and treatment planning in dentistry	.800		.107	.124	-.223
AI can revolutionize dentistry in general.	.790	.115	.309	.189	.118
Do you agree that the use of AI should be recommended to fellow practitioners	.133	.754	.437		.204
If there is disagreement between AI judgment and dentist's judgment, I will follow AI's judgment?		.657	.298	.102	-.110
Are you of the opinion that AI should be introduced in curriculum of graduate and post graduate dental students?	.318	.616		.247	
AI will be helpful to budding dentists in diagnosing and for decision making in difficult clinical situations.	.358	.559			-.452
Do you think AI can be a useful tool for boosting performance and enhancing the quality of care in orthodontics?	.198	.232	.802		
AI can be perceived as a partner rather than a competitor in foreseeable future of dentistry	.282	.103	.693	.309	
The incorporation of AI to CBCT analysis will be a valuable addition to diagnosis and treatment planning	.286	.102	.103	.857	
Do you agree that AI software for post treatment smile prediction (like Smile view in Invisalign), can increase the patient acceptance for orthodontic correction?	.107		.227	.816	
AI can be a useful tool in decision making for orthognathic surgery of skeletal malocclusions using lateral cephalograms.	.445			.743	
AI for bone age assessment using CVMI staging can be a helpful tool to overcome inter examiner bias	-.138	.412		.699	
You are currently using AI in cephalometry for			.297	.205	.674
AI can be used in orthodontics for	.173	.520	-.137		.573
Which is the best and most accurate software for CVMI assessment using AI?		.201	.163	.278	-.556

decision-making for orthognathic surgery, and 84 % find AI useful for bone age assessment.

5.5. Factor 5: Current usage of AI for cephalometric analysis

62.5 % of clinicians and 40 % of students are currently not using AI for cephalometric analysis ($p = 0.033$).

6. Discussion

Artificial intelligence has taken the world by storm, whether it is the fields of education, entertainment, industry, the medical field or dentistry. We are using many AI applications in our daily lives, like Siri and Alexa, as personal assistants and also for speech recognition, text recognition, and email spam filters on our electronic devices. In this study it was observed that academicians were more aware of it, followed by PG students and then clinicians ($p = 0.002$), whereas 25 % of clinicians were not at all aware. When asked to name the apps, all the academicians successfully did it, followed by PG students and clinicians ($p = 0.000$). The majority of academicians claim that they have a basic understanding of terminologies like deep learning and machine learning, followed by clinicians and PG students ($p = 0.002$). This suggests that academicians are more aware of AI terminologies and apps and their usage in general as compared to clinicians and PG students. Similar findings were reported by Krishnapraksh¹³ in a cross-sectional study on preventive dentistry. The major source of information about AI was web browsing and social media for all the participants (Fig. 1). Fear of job replacement is the major reason discouraging medical students to take up radiology as a specialty with the advent of AI in radiodiagnosis.^{14,15} In our study only 8 % of the PG students were worried about replacement by machines. Although less human interaction with patients was the major concern of the orthodontic fraternity as a whole (Fig. 2), more than 75 % of the participants believe that AI can be a useful tool in diagnosis and treatment planning and can revolutionize dentistry in general. This is in agreement with the study by Jebilla et al.¹⁶ where in the participating dentist suggested the use of AI as an adjunct in diagnosis and treatment planning. 72 % perceive AI as a partner rather than a competitor in the foreseeable future of dentistry. They agree that AI should be recommended to fellow practitioners, although they will stick to the dentist's judgment in case a conflict arises between AI and the dentist. Similarly Jeong et al.¹⁷ in a study on South Korean dentist stated that they would rely on the judgment of humans, when their opinions and those of AI differed.

The present state of AI applications in orthodontics can be categorized into the following domains: (1) Diagnosis, including cephalometric analysis, skeletal classification,^{18,19} model analysis, facial scan analysis,

skeletal-maturation-stage determination,²⁰ and upper-airway obstruction assessment; (2) Treatment planning, including decision-making for extractions, orthognathic surgery, and post-treatment outcome prediction; and (3) Clinical practice, including practice management, remote communication, tele-orthodontics, and clinical documentation. In a systematic review by Mohammad-Rahimi et al.,²¹ the most promising applications were cephalometric landmark detection, skeletal classification, and decision-making on tooth extractions.

The majority of the orthodontic fraternity (84 %) thinks that AI can be a useful tool for boosting performance and enhancing quality care in orthodontics. 75 % of the clinicians and 70.6 % of the academicians somewhat agree that AI can be used as a quality control system to evaluate treatment results ($p = 0.004$). The orthodontic fraternity (90 %) in the current study believes that the incorporation of AI into CBCT analysis will be a valuable tool for diagnosing complex situations. In a study by Sur²² on AI in the field of Oral radiology, 51 % of the dental professionals agreed that the major function of AI would be the interpretation of complicated radiographic scans. There is a general consensus amongst the orthodontic fraternity and students (86 %) that AI can be a useful tool for planning the complexities of treatment for patients in need of orthognathic surgery, and they also believe in AI's ability for bone age assessment via CVMI staging. AI-based bone age assessment can be done either by studying hand and wrist radiographs or by studying the maturation stages of cervical vertebrae. Kim et al.²³ proposed the use of deep learning models for estimating cervical vertebrae maturation from lateral cephalograms, with a focus on the C2–C4 regions. Seo et al.²⁴ compared the performance of six state-of-the-art convolution neural network (CNN)-based deep learning models for cervical vertebral maturation (CVM) on lateral cephalometric radiographs and concluded that Inception-ResNet-v2 performs the best. We are aware of the fact that functional jaw orthopedics and orthognathic surgeries are heavily dependent on bone age assessment, and thus AI can prove to be a boon in decision-making.

AI-based software for treatment outcome simulation post-orthodontic correction, like “smile view” (Align Technology, Inc.; Invisalign), is being used by many orthodontists for patient communication to show patients their potential new smile after treatment using in-face visualization and/or 3D dentition view. 94 % of academicians and 88 % of PG students somewhat/strongly agree that it has the potential to increase patient's acceptance of orthodontic treatment, although 12.5 % of the clinicians somewhat disagree ($p = 0.012$).

AI has a multitude of uses in the field of cephalometry, ranging from automated landmark identification to cephalometric tracings and automated cephalometric analysis. Lin et al.²⁵ stated that AI-assisted cephalometric applications were believed to make clinical diagnostic analysis more convenient and straightforward for practitioners and even

Table 4

Participants responses to questions regarding attitude towards AI in dentistry and usage in orthodontics, as per factor analysis (*p < 0.05 significant).

Question	Academician	Clinician	Postgraduate Student	Total	P-value
Factor 1: Attitude towards AI usage					
AI can be used as a quality control system to evaluate the treatment results/success					
Strongly disagree	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0.004*
Somewhat disagree	0 (0.0 %)	0 (0.0 %)	6 (12.0 %)	6 (6.0 %)	
Undecided	0 (0.0 %)	4 (25.0 %)	8 (16.0 %)	12 (12.0 %)	
Somewhat agree	24 (70.6 %)	12 (75.0 %)*	26 (52.0 %)	62 (62.0 %)	
Strongly agree	10 (29.4 %)	0 (0.0 %)	10 (20.0 %)	20 (20.0 %)	
AI can be used as a tool for diagnosis and treatment planning in dentistry					
Strongly disagree	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	0.231
Somewhat disagree	2 (5.9 %)	2 (12.5 %)	6 (12.0 %)	10 (10.0 %)	
Undecided	0 (0.0 %)	2 (12.5 %)	6 (12.0 %)	8 (8.0 %)	
Somewhat agree	22 (64.7 %)	6 (37.5 %)	28 (56.0 %)	56 (56.0 %)	
Strongly agree	10 (29.4 %)	6 (37.5 %)	10 (20.0 %)	26 (26.0 %)	
AI can revolutionize dentistry in general.					
Strongly disagree	0 (0.0 %)	0 (0.0 %)	4 (8.0 %)	4 (4.0 %)	0.215
Somewhat disagree	0 (0.0 %)	2 (12.5 %)	2 (4.0 %)	4 (4.0 %)	
Undecided	6 (17.6 %)	2 (12.5 %)	6 (12.0 %)	14 (14.0 %)	
Somewhat agree	18 (52.9 %)	8 (50.0 %)	30 (60.0 %)	56 (56.0 %)	
Strongly agree	10 (29.4 %)	4 (25.0 %)	8 (16.0 %)	22 (22.0 %)	
Factor 2: Recommending AI to fellow practitioner					
Do you agree that the use of AI should be recommended to fellow practitioners					
Strongly disagree	0 (0.0 %)	2 (12.5 %)	2 (4.0 %)	4 (4.0 %)	0.109
Somewhat disagree	0 (0.0 %)	0 (0.0 %)	2 (4.0 %)	2 (2.0 %)	
Undecided	8 (23.5 %)	2 (12.5 %)	8 (16.0 %)	18 (18.0 %)	
Somewhat agree	18 (52.9 %)	6 (37.5 %)	32 (64.0 %)	56 (56.0 %)	
Strongly agree	8 (23.5 %)	6 (37.5 %)	6 (12.0 %)	20 (20.0 %)	
Factor 3: AI as a partner in dentistry					
Do you think AI can be a useful tool for boosting performance and enhancing the quality of care in orthodontics?					
Strongly disagree	0 (0.0 %)	0 (0.0 %)	4 (8.0 %)	4 (4.0 %)	0.099
Somewhat disagree	0 (0.0 %)	0 (0.0 %)	2 (4.0 %)	2 (2.0 %)	
Undecided	2 (5.9 %)	2 (12.5 %)	6 (12.0 %)	10 (10.0 %)	
Somewhat agree	14 (41.2 %)	10 (62.5 %)	26 (52.0 %)	50 (50.0 %)	
Strongly agree	18 (52.9 %)	4 (25.0 %)	12 (24.0 %)	34 (34.0 %)	
AI can be perceived as a partner rather than a competitor in foreseeable future of dentistry					
Strongly disagree	0 (0.0 %)	0 (0.0 %)	2 (4.0 %)	2 (2.0 %)	0.344
Somewhat disagree	0 (0.0 %)	0 (0.0 %)	4 (8.0 %)	4 (4.0 %)	
Undecided	6 (17.6 %)	6 (37.5 %)	10 (20.0 %)	22 (22.0 %)	
Somewhat agree	16 (47.1 %)	6 (37.5 %)	20 (40.0 %)	42 (42.0 %)	
Strongly agree	12 (35.3 %)	4 (25.0 %)	14 (28.0 %)	30 (30.0 %)	
Factor 4: Utility of AI in orthodontics					
The incorporation of AI to CBCT analysis will be a valuable addition to diagnosis and treatment planning					
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.835
Somewhat disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Undecided	2 (5.9 %)	2 (12.5 %)	6 (12.0 %)	10 (10.0 %)	
Somewhat agree	18 (52.9 %)	8 (50.0 %)	28 (56.0 %)	54 (54.0 %)	
Strongly agree	14 (41.2 %)	6 (37.5 %)	16 (32.0 %)	36 (36.0 %)	
Do you agree that AI software for post treatment smile prediction (like Smile view in Invisalign), can increase the patient acceptance for orthodontic correction?					
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.012*
Somewhat disagree	0 (0.0 %)	2 (12.5 %)	0 (0.0 %)	2 (2.0 %)	
Undecided	2 (5.9 %)	2 (12.5 %)	6 (12.0 %)	10 (10.0 %)	
Somewhat agree	18 (52.9 %)	4 (25.0 %)	30 (60.0 %)*	52 (52.0 %)	
Strongly agree	14 (41.2 %)	8 (50.0 %)	14 (28.0 %)	36 (36.0 %)	
AI can be a useful tool in decision making for orthognathic surgery of skeletal malocclusions using lateral cephalograms.					
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.324
Somewhat disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Undecided	4 (11.8 %)	2 (12.5 %)	8 (16.0 %)	14 (14.0 %)	
Somewhat agree	16 (47.1 %)	10 (62.5 %)	32 (64.0 %)	58 (58.0 %)	
Strongly agree	14 (41.2 %)	4 (25.0 %)	10 (20.0 %)	28 (28.0 %)	
AI for bone age assessment using CVMI staging can be a helpful tool to overcome inter-examiner bias					
Strongly disagree	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.215
Somewhat disagree	2 (5.9 %)	0 (0.0 %)	0 (0.0 %)	2 (2.0 %)	
Undecided	2 (5.9 %)	4 (25.0 %)	8 (16.0 %)	14 (14.0 %)	
Somewhat agree	20 (58.8 %)	10 (62.5 %)	30 (60.0 %)	60 (60.0 %)	
Strongly agree	10 (29.4 %)	2 (12.5 %)	12 (24.0 %)	24 (24.0 %)	
Factor 5: Current Usage of AI for cephalometric analysis					
Factor 5: You are currently using AI in cephalometry for					
Not using AI	12 (35.3 %)	10 (62.5 %)*	20 (40.0 %)	42 (42.0 %)	0.033*
Automated landmark identification and cephalometric analysis	7 (20.6 %)	2 (12.5 %)	20 (40.0 %)	29 (29.0 %)	
Cephalometric tracings	11 (32.4 %)	2 (12.5 %)	4 (8.0 %)	17 (17.0 %)	
Manual landmark identification and cephalometric analysis	4 (11.8 %)	2 (12.5 %)	6 (12.0 %)	12 (12.0 %)	

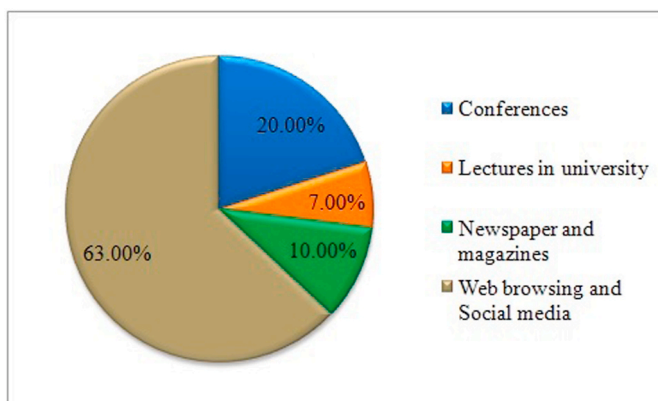


Fig. 1. Source of knowledge about AI.

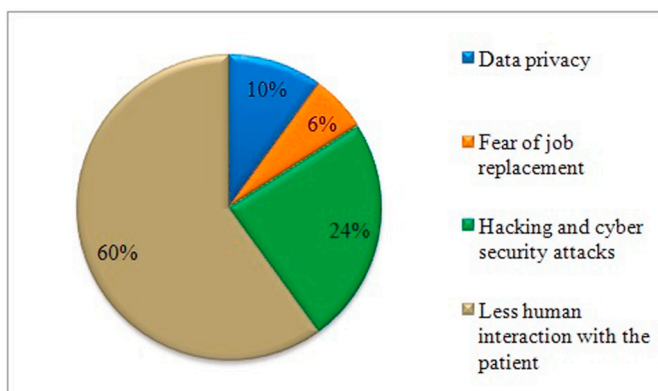


Fig. 2. Major concerns of AI usage.

replace manual and semiautomatic approaches.

The results of the study once again strengthen our faith in Artificial Intelligence technology, as most of the respondents have a positive attitude towards its usage in dentistry and orthodontics. This study will encourage the orthodontic fraternity members to plunge into AI technology without reservations. On the contrary, some hard facts were also unveiled; in spite of recognizing the importance and advantages of artificial intelligence, 62.5 % of clinicians are not using AI. It is probably an indication of the high expense incurred on owning this technology. Policy makers and manufacturers should try to bring down the cost of such equipments and software's to make them more affordable. 40 % of the post graduate students not using AI in cephalometry ($p = 0.033$) again draws attention as majority of the academicians from similar or same institutions are using it. Academic coordinators and teachers need to encourage the usage of AI technology amongst postgraduate students to unleash the advantages AI has to offer in the field of orthodontics and more importantly to make them abreast with the current trends. AI based systems are likely to change the fundamental way we practice and clinicians will be required to constantly re-skill themselves to stay relevant in the current healthcare environment. Orthodontists should also become aware of the potential challenges and pitfalls of interpreting and using AI based systems.²⁶

7. Limitations

The study was limited to Northern part of India. A pan India study will present a broader outlook about the knowledge, attitude, perception and usage of AI by orthodontic students, academicians and clinicians of the country as a whole.

8. Conclusion

In our study, it was observed that academicians are more aware of AI terminologies and usage as compared to PG students and clinicians. It is agreed by the orthodontic fraternity that AI is a useful tool for diagnosis and treatment planning (especially for complex malocclusions needing orthognathic surgeries), boosting performance and quality care in orthodontics, and revolutionizing dentistry in general. In spite of their belief in AI technology, 62.5 % of clinicians and 40 % of postgraduate students are not using it for cephalometry. There is a need to overcome the mental block and make the most of the AI technology available at our doorstep.

Ethical clearance

Ethical approval has been obtained from Institutional ethics committee of Indira Gandhi Government Dental College, Jammu vide letter no IEC/GDC/85/2024.

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Appendix A. Supplementary data

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