A Survey to Assess Awareness and Knowledge on the Role of Artificial Intelligence (AI) in Dentistry among Dental Teaching Faculty from Various Dental Colleges across India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of present study was intended to assess the dental teaching faculty of various dental colleges across India were how much aware and know about the role of Artificial Intelligence (AI)in Dentistry.

Study Design: A descriptive cross-sectional study was performed using a pre-designed questionnaire through various social media.

Place and Duration of Study: Through e-mails, and Whats App, the Questionnaire was sent to the participants of various dental colleges across India from 6th February 2023 to 31st March 2023.

Methodology: Validated and pre-tested questionnaire was used and sent to dental teaching faculty of various dental institutions across India. A total of 407 responses were received. The received data was entered in Microsoft Excel sheet. Descriptive Statistical Analysis was done by using IBM SPSS version 26.

Results: A total of 407 faculty members participated. Associate Professors/Readers stood in first place (149) and the least participation from Assistant Professors/Senior Lecturers (43). Gender wise males are dominated (217) than females (190). 42.4% of Professors were aware about the applications of AI already using in Dentistry and 93.9% of the participants of the opinion that in the future, AI is threat for the dentists.

Conclusion: Almost all the participants expressed their opinion on AI based treatment which will be accepted by the patients and all the teaching faculty members knows about the latest advances of AI in dentistry.

1. INTRODUCTION

In today's world most of the population enjoying the fruits of technology by applications of Artificial Intelligence (AI).The work completed by Traditional human intelligence is replaced by using computers, the Artificial Intelligence is performing now, processing large amounts of data in ways that humans cannot. AI can judge the things like humans, can recognize patterns, make decisions. With the assistance of new AI technology, the traditional medical environment has changed a lot. For all non-human intelligence, the universal expression is Artificial Intelligence (AI). The subgroup of AI is termed as Machine Learning (ML). By reposit, interpret and updating the patient data, the ML can assist clinicians [1-3].

The revolution witnessed in all fields of industries, by the involvement of AI. Artificial Intelligence (AI)gradually cuddling in to dentistry [2,4,5]. [AI is a supplemental tool to reduce the workload of dental personnel and improve precision and accuracy in diagnosis, decision-making, treatment planning, prediction of treatment outcomes, and disease prognosis.All specialities of dentistry testimony the colours of the application of AI. To enjoy the fruits of results of AI dentistry by all the dental fraternity, one should be aware and having knowledge in this newer technology. The best medium to educate the dental personnel by means of teaching in their UG/PG dental courses. Though the AI is not included in the regular dental teaching curriculum, to achieve the knowledge of AI, the dental teaching faculty should be aware of AI and having best knowledge in applying AI in the dental teaching. So far there is only one research study is available on the awareness and knowledge of dentists on AI and its applications in dentistry, but there is no dental literature available on dental teaching faculty on these types of studies. Hence this survey research undertaken to assess the awareness and knowledge about Artificial Intelligence in dentistry among teaching faculty of various Dental Institutions across India.

2. METHODOLOGY

2.1 Study Design

Descriptive cross-sectional study.

2.2 Study Population

Dental teaching faculty working in various Dental Institutions across India.

2.3 Sampling Criteria

Purposive Sampling.

2.4 Study Instrument

Using validated and pre-designed closed end questionnaire (Annexure-I) was sent to dental teaching faculty of various dental colleges across India through E-mails and through various social media groups, from 6th February 2023 to 31st March 2023.For approximate validation of the questionnaire, (a). A questionnaire construction expert was involved during the preparation of the questionnaire. (b) it was sent to various dental teaching faculty across India, to get face validity of the questionnaire and (c). A pilot study was undertaken with 40 participants. The questionnaire comprised of 14 questions which were divided into three parts in which the (I) section contains questions regarding demographic data, the (II) section contained information regarding awareness Artificial Intelligence (AI) in dentistry, and the (III) section included questions regarding knowledge about Artificial Intelligence (AI)and its role in dentistry including the latest inventory of AI applications in dental field.

2.5 Statistical Analysis

The received data was collected and transferred onto the Microsoft Excel sheet. The descriptive Statistical Analysis was done by using Statistical Package for Social Sciences (SPSS) 19 (SPSS Inc., Chicago, IL, USA). The descriptive statistics were done to estimate frequency and percentage for responses of the participants. Using Chi-Square test ($X2$) used to analyze<the data and P value < 0.05 was set as significant.

3. RESULTS

A total of 407 participants were responded.

(I). Demographic Details

Fig. 1 represented the distribution of the total participants in designation wise, which includes 83 Professor& Head Of the Departments (Prof & HODs),132 Professors, 149 Associate Professors/Readers and 43 Assistant Professors /Sr. Lecturers.

Fig. 2 explains the gender distribution of the participants. A total of 53.3% of male participants represented all the designations. Among all the designations, 81(61.37%) male professors and among female participants 97(65.10%) from the Associate/Reader category.

(II). Dental Teaching Faculty Awareness on the role of AI in Dentistry

Fig. 3 reveals us about awareness of the teachers on Artificial Intelligence (AI) applications which are already practicing in the dentistry. 67.6% were aware of the AI based applications that have already been used in the dentistry. When it comes to individual designations, Prof & HODs stood in first place with 74.7% than others and Associate Professors/Readers in the last with 57.6%. The results obtained were statistically significant [P = 0.022].

Fig. 4 depicts the awareness of the participants, on Artificial Intelligence (AI) and Machine Intelligence (ML) are the same or not. A lion head share of participants (88.5%) was aware that AI and ML are the same. Among them, Professors took first place with 100% acceptance that both are same, followed by Assistant Professors/Sr. Lecturers with 95.3%, later Prof& HODs with 89.2% and finally the Associate Professors/Readers with 75.8%. The results obtained were statistically highly significant [P = 0.000].

Fig. 5 mentioned about the faculty who are aware of AI based Virtual Dental Assistants are available in the market. Out of all the designations only 47.4% of the participants were aware of it. When it comes to individual designations, 100% of participants from Prof & HODs category and Assistant Professors/ Sr. Lecturers category was aware about availability of virtual dental assistants in the market. Whereas the least awareness seen among Professors (6.1%). The results obtained were statistically highly significant [P = 0.000].

Fig. 6 commenting on the awareness of faculty members on Dental Chairs working on AI based Voice command. A very less percentage of faculty members (32.4%) only reveals about the AI based voice command dental chairs. With individual designations Professors stood in first place (42.4%) and least with Prof & HODs (25.3%). The results obtained were statistically significant [P = 0.022].

(III).Dental Teaching Faculty knowledge on the role of AI in Dentistry

Table 1 shows the knowledge of teaching faculty on Virtual Dental Assistants powered by AI carry out work with more accuracy with fewer mistakes, than human counter parts. Very less percentage (32.4%) of the participants knew that

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virtual dental assistants could perform with more accuracy. Among all the designations, the Professors (42.4%) comparatives knows better than others. The results obtained were statistically highly significant [P = 0.000].

Fig. 7 stating about the knowledge of dental teaching faculty on whether AI can replicate human emotions. Except 3.6% of Prof & HODs rest 100% faculty members were strongly felt that, AI cannot replicate human emotions. The results obtained were statistically significant [P = 0.008].

Fig. 8 describes the knowledge of dental teaching faculty regarding the 'Haptic gloves' which can provide a unique experience of touch. Almost all the designations (98.5%) knowsabout the unique feature of Haptic gloves which can provide touch sensation. The results obtained were statistically significant [P = 0.001].

Fig. 9 portrays about AI can accurately predict a genetic predisposition for oral cancer for a large population. Almost all the faculty members (99.3%) are of the opinion that AI cannot accurately predict a genetic predisposition for

oral cancer for a large population. The results obtained were statistically significant [P = 0.008].

Fig. 10 mentioned on the knowledge of faculty members on AI can create complete virtual database for every patient. All the participant faculty members (99.3%) know that the usage of AI applications can provide complete virtual database of the patients. The results obtained were statistically significant [P = 0.022].

Table 2 explains regarding the opinion of dental teachers on AI will be a threat for Dentists in the future. 93.9% of faculty of opinion that AI will be a threat for the dentists in the future, and Professors (100%) are strongly felt that it will be a threat in the future. The results obtained were statistically highly significant [P = 0.000].

Table 3 depicts the opinion of faculty members on AI based treatment will be accepted by the patients. Lion head share (98.5%) of the participants believed that patients would accept the AI based treatments. Both Professors and Associate Professors totally in favour of AI based treatments will get approval from the patients easily. The results obtained were statistically highly significant [P = 0.001].
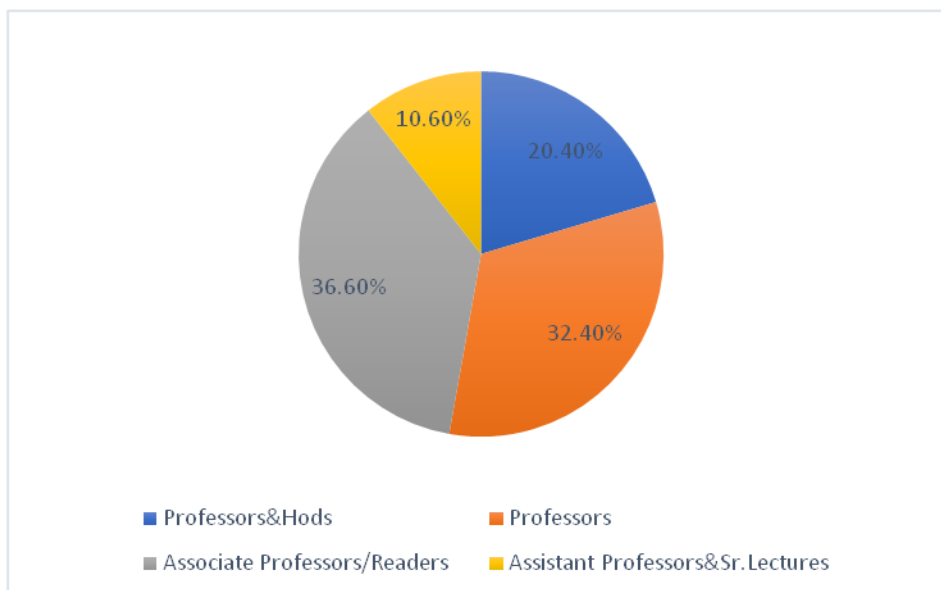
(I). Demographic Details

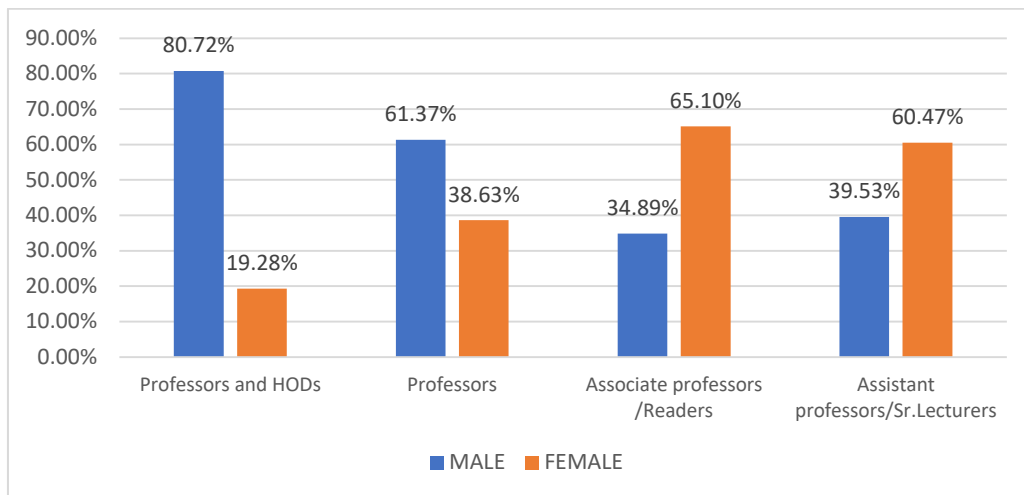**Fig. 1. Distribution of subjects according to their Designation**

Fig. 2. Distribution of subjects according to their gender

(II). Dental Teaching Faculty Awareness on the role of AI in Dentistry:
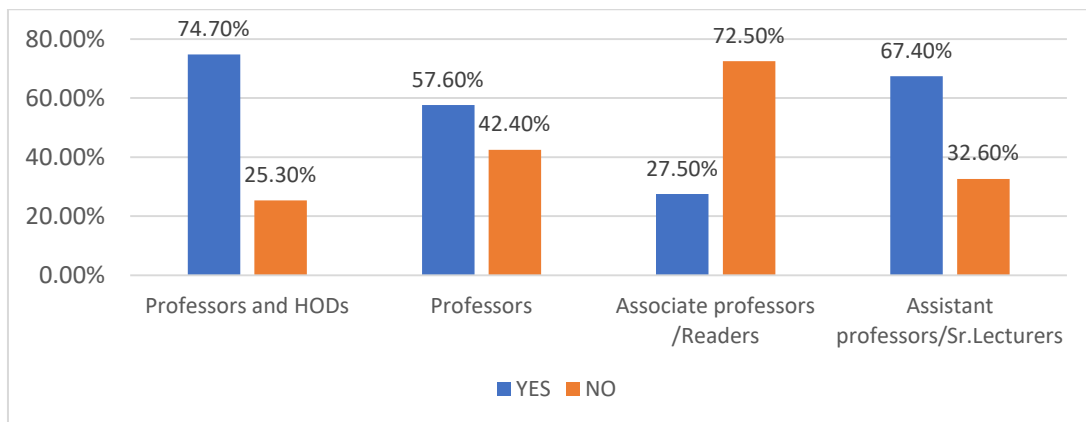

Fig. 3. Distribution of subjects aware of artificial intelligence (AI) applications which are already practicing in dentistry
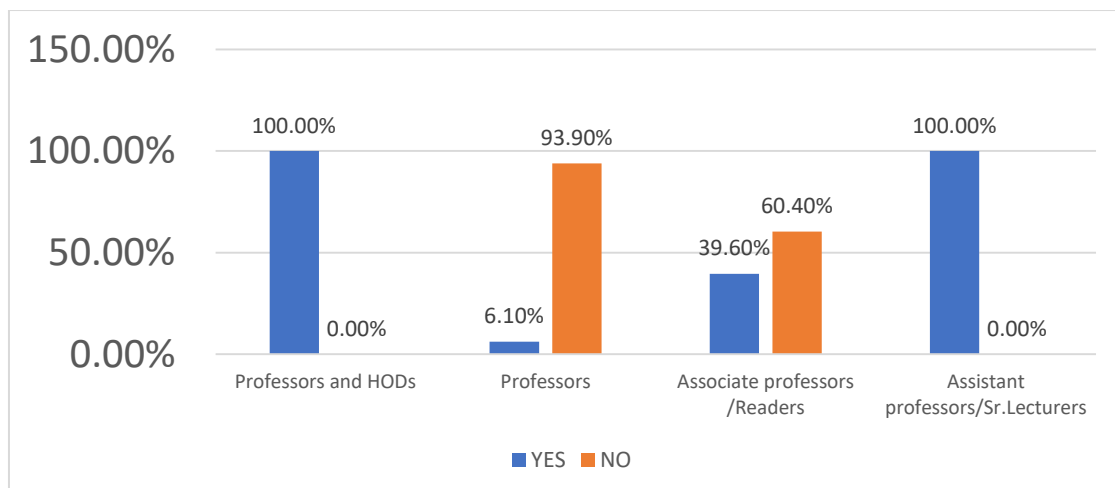

Fig. 4. Distribution of subjects according to their awareness on Artificial intelligence (AI) and machine intelligence are the same
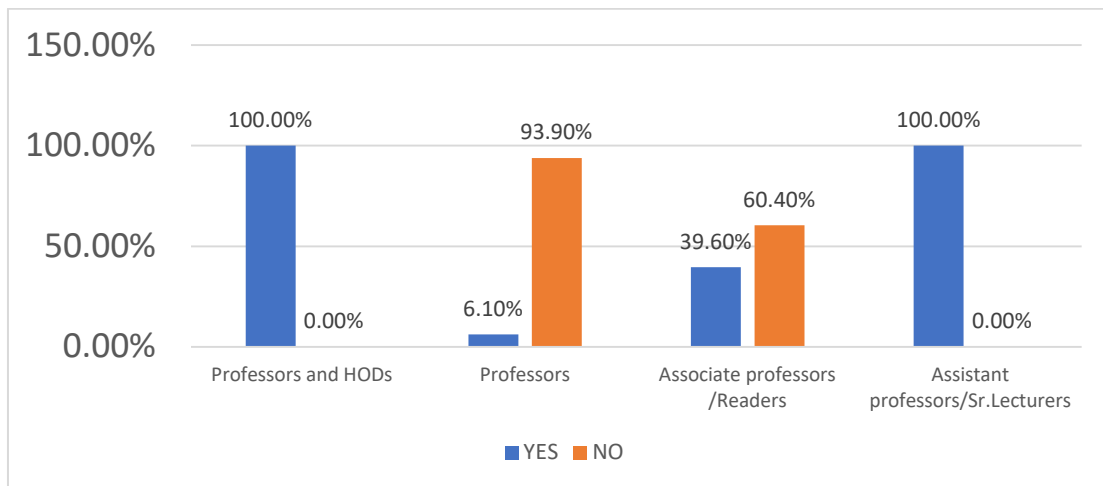
Fig. 5. Distribution of subjects according to their awareness on AI based virtual dental assistants are available in the Market
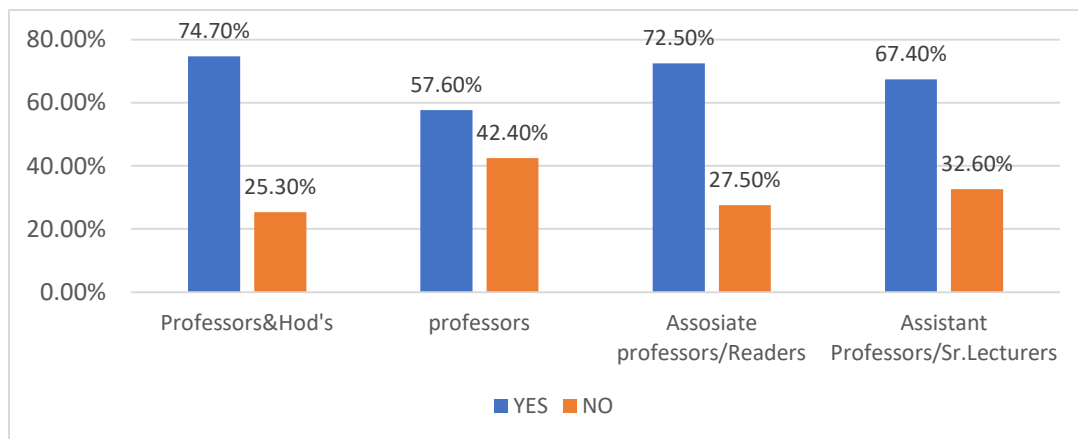

Fig. 6. Distribution of subjects according to their awareness on Dental chairs working on AI based Voice command

(III). Dental Teaching Faculty knowledge on the role of AI in Dentistry

Table 1. Distribution of subjects according to their knowledge on virtual dental assistants powered by AI carry out work with more accuracy with fewer mistakes, than human counter parts

Designation	Response-Yes	No	Total
Professor&HODs	21(25.3%)	62(74.7%)	83(100.0%)
Professors	56(42.4%)	76(57.6%)	132(100.0%)
AssociateProfessors/Readers	41(32.4%)	108(72.5%)	149(100.0%)
AssistantProfessors/Sr.Lecturers	14(32.6%)	29(67.4%)	43(100.0%)
Total	**132(32.4%)**	**275(67.6%)**	**407(100.0%)**

$X2$Value=19.176,P=0.000 (Highly Significant)
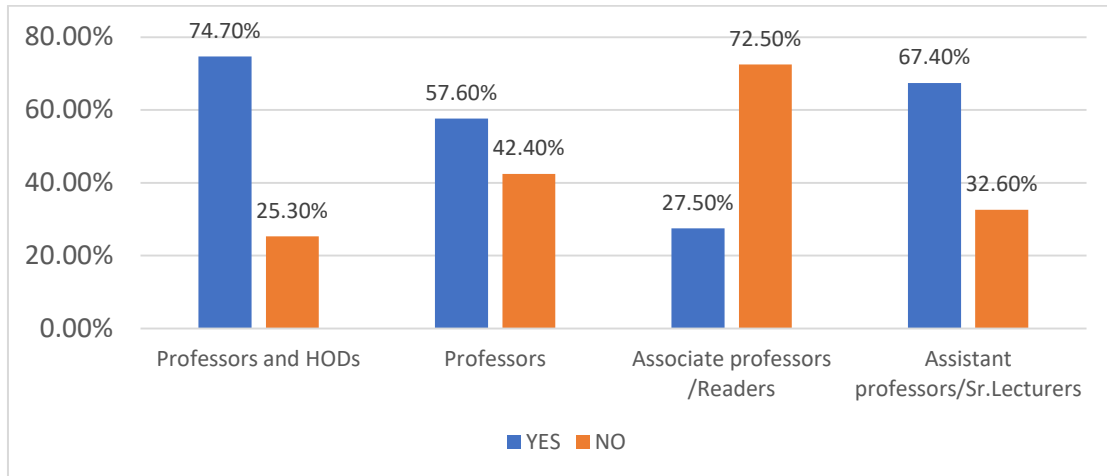
Fig. 7. Distribution of subjects according to their knowledge on whether artificial intelligence (AI) can replicate Human Emotions
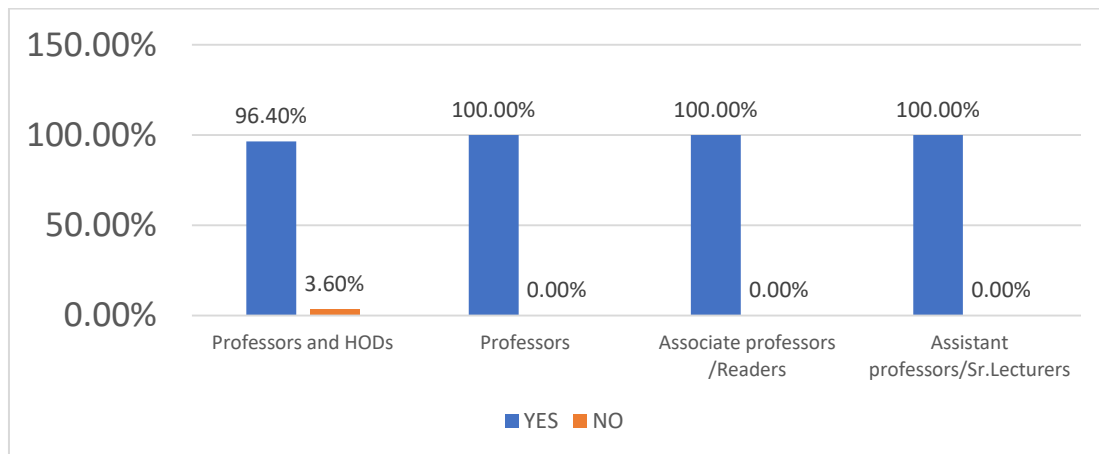

Fig. 8. Distribution of subjects Whether Haptic gloves which can provide a unique experience of touch
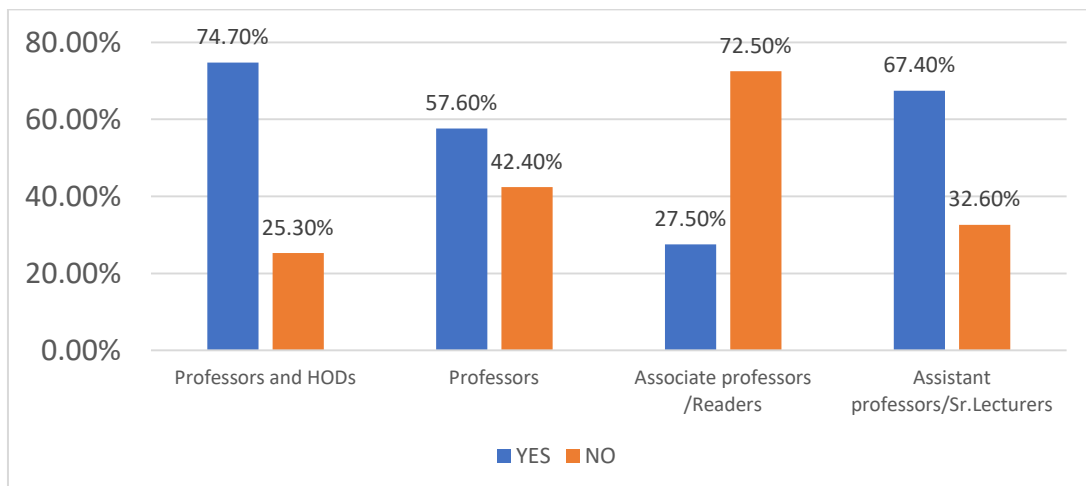

Fig. 9. Distribution of subject's opinion on AI can accurately predict a genetic predisposition for oral cancer for a large population
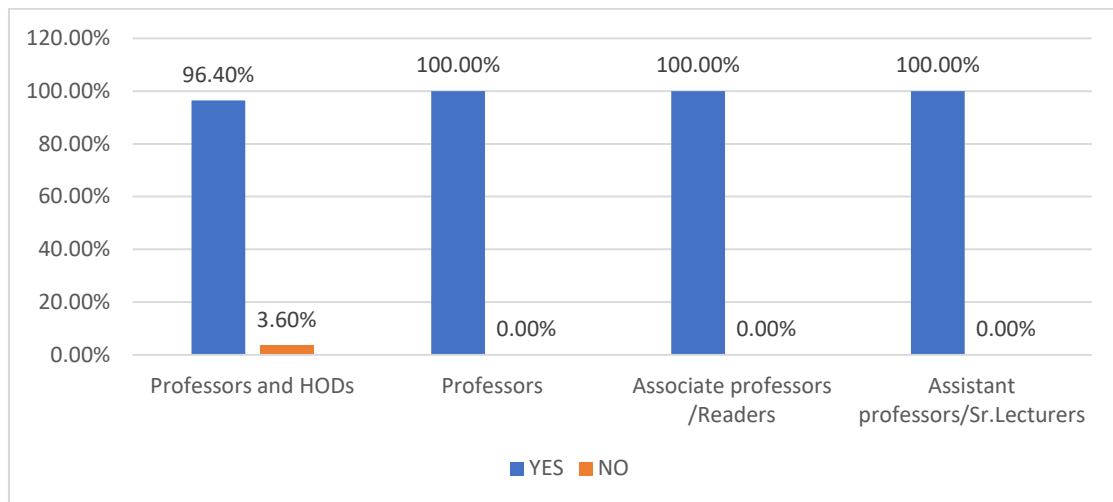
Fig. 10. Distribution of subjects according to Knowledge on AI can create complete Virtual data base for every patient

Table 2. Distribution of subjects according to their opinion on AI will be a threat for Dentists in the future

Designation	Response-Yes	No	Total
Professor&HODs	80(96.4%)	3(3.6%)	83(100.0%
Professors	132(100.0%)	0(0.0%)	132(100.0%)
AssociateProfessors/Readers	131(87.9%)	18(12.1%)	149(100.0%)
AssistantProfessors/Sr.Lecturers	39(90.7%)	4(9.3%)	43(100.0%)
Total	**382(93.9%)**	**25(6.1%)**	**407(100.0%)**

X2value=19.416,P=0.000 (Highly Significant)

Table 3. Distribution of subjects according to opinionon AI based treatment will be accepted by the patients

Designation	Response-Yes	No	Total
Professor&HODs	80(96.4%)	3(3.6%)	83(100.0%)
Professors	132(100.0%)	0(0.0%)	132(100.0%)
AssociateProfessors/Readers	149(100.0%)	0(0.0%)	149(100.0%)
AssistantProfessors/Sr.Lecturers	40(93.0%)	3(7%)	43(100%)
Total	**401(98.5%)**	**6(1.5%)**	**407(100.0%)**

X2value=15.786,P=0.001(Significant)

4. DISCUSSION

Artificial Intelligence (AI) was expressed as "machines thinking" by Turing AM and proposed a test by name 'Turing test' to assess human-level intelligence can be achieved by the machine. In the present study major percentage of participants (88.5%) were aware that Artificial Intelligence (AI) and Machine Intelligence (ML) are the same [6]. As per Banerjee M et al. [3]; Ma J et al. [7] and Isra ST et al. [8] AI is just an application, and it cannot replace the human brain, rather it will support the doctor by providing extra information and carefully can assist with accuracy the clinician. Present study results strongly (99.3%) stating that AI cannot replicate human emotions. According to Sefira F [9] "AI will notify the things which are not able to notice by the humans".

The AI can be useful tool for patient education such as Genius X, toothbrush from Oral-B, perceive brushing types and trainer users [5]. Few of the dental institutions already started to be escalating the importance of AI as training for the dental students learning in the better way. As per Topol EJ [10], by providing reduced post operative problems, declining redundant procedures, and providing better quality of health.

Dental practice already witnessing the use of Virtual Dental assistants which are available in the market. As per Khanna S et al. [11] and Rieshy V et al. [12] the virtual assistants can execute some routine works of the physical assistants with better accuracy than the physical dental assistants. In our present study, 47.4% teaching faculty were aware about the availability of Dental Virtual Assistants in the market.

Lim K et al. [13] and Yeager D et al. [14] stated that, the AI application helps to identify the malignant and premalignant changes of the oral mucosa and aids in the better treatment. According to Bas B et al., it is possible to identify the low and high-risk malignant lesions and suggest treatment planning. [15] Whereas Majumdar B et al., mentioned Artificial intelligence might accurately predict a genetic predisposition for oral cancer for a large population [16]. Whereas our study results are contradicting the above study results.

The applications of Artificial Intelligence (AI), already showing its footprints in various dental speciality treatments which includes Radiology and diagnosis [15,16], Pediatric Dentistry [17]; Periodontics [18,19]; Implantology [20,21]; Maxillofacial Surgery [22]; Orthodontics [23-25]; Prosthodontics [2,26-29]; Endodontics [30,31]; and Forensic Odontology [32]. The present study 67.6% participants of the opinion that AI based applications are already using in various dental specialities.

The application of AI is taking slow momentum in the dental field but leaving some hindrances in the minds of the clinicians. According to Tandon D Rajawat [33], the mechanism of AI use is very intricating, very expensive and need meticulous training to handle the software and bias regarding possibility of detaining of patient data.

Though the usage of AI started very long back in medical field, in dentistry the applications started four decades back. The applications of AI started in the dental tutoring systems since its inception into dentistry [34]. According to Crowley R et al. [35] by using virtual patients, the student community shown tremendous improvement in their preclinical skills. The application of AI in the form of UMLS (Unified Medical Language System), which is a big leap in the manual teaching. As per Feeney L et al. [36] by the application of AI in the training of dental students, the students individually can assess themselves as well as they can attain better professional skills.

It is possible to create complete virtual database to all the patients with the help of AI software, and many dentists are using in the world since long time [37,38]. The present research results were also in line with the previous studies. According to Aminoshariae A et al. [39] AI usage is economical, authentic, competent, rigorous, and quicker. As per Shan T et al. [40] the AI cannot provide human communication which plays a crucial role while providing health care services such as clinical hunch and not having physical touch of sense.

Nguyen TT et al. [41] raised some doubts regarding the uses of AI in dentistry regarding the accountability. Though the AI usage is showing some promising clinical results, but who will be liable for any conflicting results or any errors from the application of AI during the treatment occurs. In the present study lion head share (93.9%) of teaching faculty expressed their opinion regarding applications of AI in the dentistry may pose threat for dentists in the future. Whereas similar type of study conducted in Saudi Arabia by Aboalshamat KT, [42] among dental professionals, a less percentage compare with present study (49.1%) agreed or strongly agreed that AI could replace dentists in the future. It is very common to have some myths while using initially any newer technology, but when we start seeing the positive results all those myths will be clarified.

But same time almost all the participants from the present study (98.5%), expressed their opinion on AI based treatment, which will be accepted by the patients

4.1 Recent Innovations

Digital Dental assistant (DeXVoice) available in the marke [43,44]. AI incorporated voice command dental chairs are available [2]. To feel the sense of touch to maintain human relations, 'Haptic gloves' are available in the market [45]. Present study results on Haptic gloves reveals that almost all the participants (98.5%) know about the exclusionary property of touch sensation. AI can easily distinguish between the healthy tissues and non-healthy tissues in the oral cavity. Bio/Screen Oral Exam Light available with incorporation of Artificial Intelligence software [46]. The utmost ingenious advent use of AI is 'bioprinting' of hard and soft tissues, and

organs in the medical field, became blessings for the patients who lost their tissues, whereas, yet to introduce the same in the dentistry [47,48].

5. CONCLUSION

Dental practitioners should understand that AI as a supplemental tool to reduce their workload and improve precision and accuracy in diagnosis, decision-making, treatment planning, prediction of treatment outcomes, and disease prognosis. The AI application in the field of patient data management, majority of dental clinicians are using and undoubtedly, they are witnessing the positive results. Thus, AI application‑based dentistry is not a myth but turning into a reality.All the dental fraternity should avail these fruits of newer technology on par with any other medical profession who are already using AI in their day to day medical/clinical practice.The teaching faculty having extra advantage of using latest technologies and they should teach their students about the recent advances including application of Artificial Intelligence and they should assure the younger dental generation that AI cannot replace humans. The apex bodies of dental teaching and Universities may consider incorporating the AI in the dental teaching curriculum.

ETHICAL APPROVAL AND CONSENT

This research has been registered with the Institutional ethics Committee board. Participants were informed that participation in the study was entirely voluntary. Participants' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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QUESTIONNAIRE

Annexure-I

I. Demographic Details:

1. Name: (Optional)   --

2. Gender: Male [   ]   Female [   ]

3. Designation:

a) Prof & HOD   [   ]   b) Professor   [   ]   c) Reader [   ]   d) Sr.Lecturer   [   ]

II. Dental Teaching Faculty Awareness on the role of AI in Dentistry:

4. Are you aware of Artificial Intelligence (AI) applications which are already practicing in the dentistry?

   Yes [ ] No [ ]

5. Are you aware that Artificial Intelligence (AI) and Machine Intelligence (ML) are the same?

   Yes [ ] No [ ]

6. Are you aware that AI based virtual dental assistants are available in the market?

   Yes [   ] No [   ]

7. Are you aware of Dental chairs working on AI based Voice command?

   Yes [   ] No [   ]

III. Dental Teaching Faculty Knowledge on the role of AI in Dentistry:

8. Do you know that Virtual Dental Assistants powered by AI carry out work with more accuracy with fewer mistakes than human counter parts?

   Yes [   ] No [   ]

9. Do you think that AI can replicate human emotions?

   Yes [   ] No [   ]

10. Do you know about 'Haptic gloves' which can provide a unique experience of touch?

   Yes [   ] No [   ]

11. Do you agree that AI can accurately predict a genetic predisposition for oral cancer for a large population?

   Yes [   ]   No [   ]

12. Do you know that AI can create a complete virtual database for every patient?

   Yes [   ] No [   ]

13. Do you think AI will be a threat for dentists in the future?

      Yes [ ] No [ ]

14. Do you think AI based treatment will be accepted by the patients?

      Yes [ ] No [ ]