Short Survey

Knowledge, Attitudes and Perception towards Artificial Intelligence and Robotics in Dentistry - A Cross-Sectional Survey

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ABSTRACT

OBJECTIVE: To evaluate dentists' knowledge, attitude and perception of robotics(R) and artificial intelligence (AI).

METHODOLOGY: Data were gathered for this cross-sectional survey from dental schools in Karachi that were both public and private. A total of 550 surveys were delivered through Google Forms. Dental students, graduates, postgraduates, and professionals of both sexes aged 20-70 years were included. Participants were chosen by convenience sampling using non-probability. Data were analyzed using descriptive analysis and the Chi-square test in SPSS version 22.0.

RESULTS: Of the 550 participants, men comprised 33% (n=181) overall, while women comprised 67%(n= 369). Despite having a great understanding of AI and R, the majority of participants, 55.1%(n=304), also have a strong point of view. However, only 42.5%(n=234) of respondents were aware of the difference between AI and R and 55.2%(n=304) have prior knowledge about AI and R. Nevertheless, 58% (n=319) of dentists thought it would be helpful for future dental procedures. Only 16%(n=88) of respondents believe artificial intelligence will eventually replace dentists. Some applicants, 55.2%(n=304), proposed employing AI/R for therapy, and 51%(n=281) agreed to get treatment.

CONCLUSION: By evaluating dentists' knowledge, attitudes, and perceptions of these technologies, it is possible to understand better the implementation of robotics and AI in clinical practice. More education and training programmes for dental professionals would be beneficial, and more studies would be able to determine the best ways to integrate robotics and AI to enhance patient results.

KEYWORDS: Artificial intelligence, digitization systems, robotics, machine learning, dentistry, dentist

INTRODUCTION

The healthcare industry across the globe will experience innovative and revolutionary developments due to improved technologies and digitization systems. Artificial intelligence and robotics are the newest developments in these technologies. John McCarthy, a mathematician from Dartmouth University, is acknowledged as the father of artificial intelligence because he proposed the idea of AI in 1956 at a workshop[1]. An area of science and engineering known as artificial intelligence (AI) is one that "is concerned with the computational understanding of what is often referred to as intelligent behavior, and with the production of artefacts that display such behavior[2].

Artificial intelligence in dentistry has proved advantageous since it closely resembles how the human brain works and can complete tasks quickly and accurately. Several facets of dentistry will undergo a radical transformation due to artificial intelligence because it supports early diagnosis, treatment planning, and evaluation standards for treatment outcomes. Our diagnosis is aided by radiographs, which can be used with imaging technologies like MRI and CBCT to find minute deviations from the norm that might have gone unnoticed by the human eye[3].

Furthermore, AI helps in orthodontic treatment planning and diagnostics. Machine learning (ML) is "a branch of study that allows computers to learn without being expressly programmed. "Machine learning is used to assist in clinical decision-making, such as whether to do extraction[4]. It is astonishing how well AI can predict oral cancer. Early detection would improve oral cancer's quality of life and survival rate[5]. In addition to implementing computer-aided design (CAD) techniques, AI models have been used for various prosthodontic applications, including mapping

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the finishing line of tooth preparations and assisting with tooth anatomy selection[6].

Technology's field of robotics is concerned with the creation, maintenance, use, and application of robots. Robots do various tasks in our daily lives to enhance our quality of life. By carrying out ordinary dental tasks, dentistry robots will create various modifications like automatically investigating, drilling, cleaning, contouring, and filling the root canal with the help of an endo micro-robot, which reduces human error[7]. Besides, these robots are used in surgery for treatments, including orthognathic surgery, deep saw osteotomy, drilling holes, and polishing the surface of the bone[8].

Beyond the use of robots for dental help, more intrusive use cases have been mentioned in the literature, including autonomous implant placement combined with difficult 3D navigation or tooth preparation operations. [9] We can treat head and neck cancer with the aid of robotic surgery. Robotics is used in a facility to help our students with their clinical training. In dental crises where contact with the dental expert is impossible, the artificial intelligence-powered digitizing system enables the patient to provide teleassistance[10]. Modern digital dentistry will change the dental industry's future in various ways.

Few studies and surveys have been undertaken on dentistry, especially in Pakistan. The rationale was also to gauge dentists' attitudes and perceptions of artificial intelligence and assess their future recommendations. This study served as a representation of Pakistani dentists' knowledge of robotics and artificial intelligence. Therefore, this study was planned to evaluate dentists' knowledge, attitudes, and perceptions regarding robotics(R) and artificial intelligence (AI).

METHODOLOGY

A cross-sectional descriptive study was conducted at Karachi Medical and Dental College, and individuals were chosen using a non-probability convenience sampling method. The Karachi Medical and Dental College's ethical review board approved the research study. Data were collected from July 2022 to December 2022. With the help of Raosoft software, the sample size of more than 550 was determined with a 95% confidence level and a 5% error. A questionnaire extracted from the published article was used in the survey. The Survey forms were distributed throughout Pakistan. Inclusion criteria were participants from both genders, who were given consent for the study, aged 20-70 years, general dentists, dental undergraduates, and postgraduate consultants and specialists. An exclusion criterion was non-consented and psychologically ill patients. The participants were contacted via emails or social media platforms. The questionnaire includes demographic information, which provides information on gender, education, experience, and knowledge of understanding robotics and artificial intelligence, dentist approach towards AI, and attitude to gauge dentists' practice toward artificial intelligence.

IBM SPSS version 25.00 was used to evaluate the data statistically. Using the chi-square test, the relationship between the affirmed and non-affirmed responses, a p-value of <0.05, was deemed statistically significant.

RESULTS

There were 550 participants including 33% (n=181) of men and 67% (n=369) of 69.4%(n= women majority of them have 1-5 years of working experience. i. e. 69.4% (382), 5 to 10 years 17.45% (96) and >10 years 12.72% (72). Undergraduate students, graduates, and postgraduates made up 32% (n=176), 39 %(n=216), and 28.7 %(n=158), respectively, of the total population.

Table I shows the evaluation of the knowledge of AI and R. It was observed that 42.5% (n=234) were aware of the distinction between AI & R, and the majority of the respondents, 55.2%(n=304) knew about AI/R. Furthermore, the majority of participants, 60.9%(n=335), agreed that artificial intelligence should be applied to radiographic inspection, and 46% (n=253) believed that it should be used in diagnosis and treatment planning, in vitals monitoring 52.4% (n=289) and in tissue sampling diagnosis 56.1% (n=309). Additionally, 50.9%(n=280) of individuals or half, supported the implementation of AI in cancer early detection.

The chi-square test is applied to affirmed vs non-affirmed responses. The results are statistically significant for all (Q1- Q7), meaning there is a difference in affirmed and non-affirmed responses of participants regarding AI knowledge(p=0.00). The control chart in **Figure I** showed that respondents provided statistically significant higher affirmative responses.

The results of the perception of AI/R reveal statistically significant, more excellent affirmative responses to all statements. It was suggested that approximately 58% (n=319) reported learning about the positive impacts of AI in dentistry. Almost equally affirmed responses were received to the questions on the significant improvements in treatment quality, 53.4% (n=294), and surgical benefits of robotics, 53.6% (n=295). AI provides a comprehensive digital image of the oral cavity, according to 64.4% (n=354) of those surveyed. In the current research, the participants agreed that AI/R aids in precise implant placement 57.8% (n=318), tooth alignment 63% (n=347), and patient information security 63.8% (n=351). Only 45.2% (n=249) of individuals believed that robots would aid in developing a successful career. Most of the respondents, 65.4% (n=360), didn't agree that AI will replace dentists in the future. **Table II**

Whereas the chi-test gives significant results for all Q8 to Q16, there is a difference in affirmed and non-affirmed responses of participants regarding AI perception. It implies that the majority of dentists have

a clear understanding of modern, cutting-edge technologies. Regarding the attitude of AI/R, of the ten questions in this part, questions 19 and 22 to 26 had statistically significant more affirmed answers. 51% (n=281) of participants prefer treatment on oneself, whereas 55.2%(n=304) support AI/R as a kind of therapy. However, 42% (n=232) believed robotic instruction would not increase their confidence. Most

Table I: Knowledge of artificial intelligence

Questions	Yes n(%)	No n(%)	I don't know n(%)	P-value (affirmed vs not affirmed)
Difference between AI and robotics	234(42.5)	212(38.5)	104(18.9)	0.000
Prior knowledge of AI and R in dentistry	304(55.2)	246(44.7)	0	0.000
AI used in diagnosis and treatment plan	253(46)	104(18.9)	193(34)	0.000
Role of robots in measuring vitals	289(52.4)	81(14.7)	180(32.7)	0.000
AI used for examinations, e.g. CBCT, MRI	335(60.9)	55(10)	160(29.1)	0.000
AI used for accurate reading of tissue samples	309	71(71)	170(30.9)	0.000
Used in the detection of oral cancer	280	72(72)	198(36)	0.000
CI	286±34.6	120±76.570.	143.42±70.45	

Figure I: Cohort chart showing answers for knowledge, perception and attitude of participants with upper and lower confidence limits

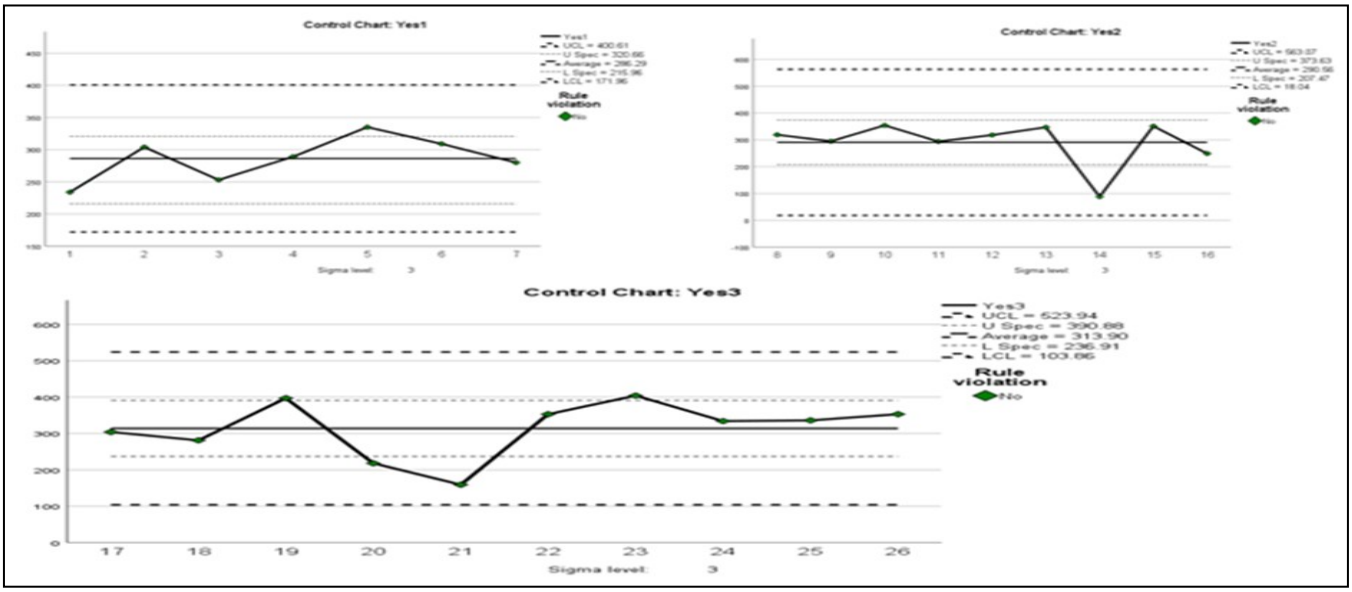

Table II: Perception of dentist towards AI and Robotics

Questions	Yes n(%)	No n(%)	I don't know n(%)	P-value (affirmed vs not affirmed)
R/AI beneficial in dentistry	319(58)	47 (8.5)	184(33.5)	0.000
Robots help to perform operations	295 (53.6)	106 (19.3)	149(27.1)	0.000
AI gives an accurate digital view of the mouth	354(64.4)	62|(11.3)	134(24.4)	0.000
Beneficial for quality of treatments	294 (53.4)	103(18.6)	153(27.8)	0.000
Prediction of correct placement of implants	318(57.8)	65(11.8)	167(30.4)	0.000
Facilitation in teeth arrangement	347 (63)	43(7.8)	160(29.1)	0.000
AI replace dentists or not	88 (16)	360 (65.4)	101(18.4)	0.000
AI secures patient's information and gives quick access	351(63.8)	68(12.3)	131(23.8)	0.000
Robots are helpful for career production	249(45.2)	143(26)	158(28.7)	0.000
CI	290±83	110.7±98.8	148.5±24.0	

Table III: Attitude of dentist towards AI and robotics

Questions	Yes n(%)	No n(%)	I don't know n(%)	P-value (affirmed vs not affirmed)
Recommend of R/AI for the treatment	304(55.2)	243(44.2)	3(0.5)	0.000
Prefer treatment with R/AI for yourself	281(51)	269(48.9)	0	0.000
Prefer robotics lab for training	397(72.1)	153(27.8)	0	0.000
Prefer robotics lectures or workshops	218(39.6)	183(33.3)	149(27.1)	0.000
Robot teaching increases self-confidence	159(28.9)	232(42)	159(28.9)	0.00
Robots as your team partner	353((64.1)	87(15.8)	110(20)	0.000
Like to learn about R/AI in the future	404(73.4)	70(12.7)	76(13.8)	0.000
AI and Robots Accepted in University	334(60.7)	86(15.6)	130(23.6)	0.000
R/AI improves clinical practice	336(61)	88(16)	126(22.9)	0.000
Create health care system with the latest technologies	353(64.18)	66(12)	131(23.8)	0.000
CI	313.9±76.8	147.7±78.8	88.4±64.2	

people, 72.1% (n=397), preferred robotics training in labs and 73.4%(n=404) were positive about learning AI/R in the future. According to our findings, only 39.6%(n=218) of our survey participants preferred robot-led lectures and workshops. Over half of respondents, or 60.7%(n=334), believed that AI and R would be encouraged in higher education or universities. Equally noteworthy responses included 64.1% (n=353) of respondents preferring robots as team members and 64.18%(n=353) believing that AI will lead to the development an advanced digital healthcare system. According to 61%(n=336) of respondents, AI/R will advance clinical practice.

The p-value after using chi-square is 0.000 (**Table III**), which means that the participant's attitude towards AI and robotics is positive. Meanwhile, the chi-square value shows significant results for the affirmed and non-affirmed responses of participants. i.e. 0.000.

DISCUSSION

Dentistry is an innovative new industry that will undoubtedly undergo digital changes. Due to the lack of studies in this field, the research aimed to assess Pakistani dentists general knowledge of AI/R.

According to research by Kumar PR et al.[11], clinicians were less aware of emerging robotics and artificial intelligence technologies for medical treatment and rehabilitation. On the other hand, 55.2% of respondents know robotics and 73.4% would be thrilled to use robotic technology in their future practice.

According to the study's findings, 67% of participants are women, making up the majority of participants. Approximately 39% of the participants were dental graduates, and the majority had 1 to 5 years of professional experience. A study by Singh N 2023[12] found that the employment of artificial intelligence in dentistry is fascinating, according to 65.97% of postgraduates. However, they were mostly unaware of the potential applications of artificial intelligence in dentistry. The survey also found that younger dentists were more likely to favor AI than older dentists.

The study's findings show that most participants had a thorough comprehension of AI/R and were aware of the differences between the two. Researchers in another study found that dentists grasp AI in dentistry somewhat. In contrast, 82% of respondents indicated they would be receptive to integrating AI into their practice, indicating a positive attitude towards the technology[13].

The study showed that dentists had a very excellent understanding of artificial intelligence compared to a prior study[11] that reported lesser knowledge. However, AI claims to increase treatment effectiveness, reliability, and accuracy since it is so good at identifying ailments in image analysis and even automatically suggesting the right test[13].

The survey found that dentists are ready to learn more about this soon and want to include it in training. The knowledge of new and contemporary technologies is essential for the upcoming generation[14]. Despite the dire need for CME activities, very few respondents consented to attend seminars and lectures conducted by robots since they believed doing so would make them less confident.

Nearly half of the participants advised it for treatments or operations, and more than half thought it would benefit dentistry. They want robots to take care of them as well. Researchers in their study found that dentists grasp AI in dentistry to an adequate level. However, 70% of the respondents indicated they would be receptive to employing technology in their jobs, showing they had a favourable view of AI. The poll also revealed that male dentists had a significantly higher level of AI comprehension than female dentists. The findings of other investigations are encouraging[2,15].

Very few respondents advocate using artificial intelligence to replace dentists. 64.2% of respondents expressed a desire to collaborate with robots. As in the study done in Saudi Arabia, eight dentists' positive and upbeat attitudes and answers about AI/R were

examined in our research in Pakistan since they were eager to learn more about it in the future. Other studies also have encouraging outcomes.

The limited sample size of the study, which did not fairly reflect the population, is an issue. So, the results cannot be generalized. The study's closed-ended questions provided little information that can make it difficult to understand how complex the subjects are, and they also failed to compel participants to provide serious responses.

Future research should investigate this on a broader scale and encompass the entire country of Pakistan; this would offer a comprehensive picture of Pakistani dentists' knowledge of AI/R. Therefore, it is crucial to teach the future generation the fundamentals of AI/R through lectures, seminars, and workshops.

Dental professionals could use AI as an augmentation tool to help them execute more valuable jobs, such as integrating patient data and enhancing professional relationships. The development of AI should go hand in hand with dentistry education[16]. There is a need to educate dentists who still don't understand artificial intelligence. Numerous research on the efficiency of AI systems for dentistry education have demonstrated that students achieve a competency-based skill level more rapidly using these systems instead of conventional ones.[20] The curriculums for every student should ideally incorporate innovative and creative learning methods. It is necessary to schedule lectures, seminars, and workshops to advance understanding of AI/R and aid in its use, enhancing healthcare.

Assessing dentists' knowledge, attitudes, and views of R and AI should use a broad approach to understand the topic thoroughly. The familiarity with specific applications and preparedness to use them in practice is feasible questions to ask regarding the perceived benefits and drawbacks of using various technologies in dentistry.

Studies should make an effort to include a sizeable and representative sample of dentists to ensure that the findings may apply to the greater dental community. One way to do this is through online surveys or by recruiting through professional associations.

Researchers should collect demographic data, including gender, age, and years of experience, to analyze potential differences in knowledge, attitude, and perception of R and AI among different subgroups of the dental profession.

Longitudinal studies may be able to monitor changes in patients' knowledge, attitudes, and impressions of dentists due to the growing usage of R and AI in dentistry.

The outcomes of these tests may be used to inform the development of educational initiatives aimed at improving dentists' knowledge of and competence in applying R and AI in dentistry.

CONCLUSION

By evaluating dentist's knowledge, attitudes, and impressions of these technologies, it is possible to understand better the adoption and deployment of robotics and artificial intelligence in clinical practice. More education, training, and research can benefit dental practitioners, who can employ R and AI to improve patient outcomes.

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AUTHOR CONTRIBUTION

Zia W: Manuscript writing, data collection, and final review

Kashif M: Data analysis, interpretation, and critical review

Aleem A: Conception, design, and manuscript writing

Raja IM: Data collection, and review

Rehman A: Data collection and literature review

Butt AI: Data collection and manuscript writing

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