



Patients' Perception of using Robotics and Artificial Intelligence in Dentistry: A Cross-sectional Study

Najla Al-Dabbagh¹, Yousef Alnowailaty², Hassan Abed³, Rayan Sharika⁴, Abdelrahman Alhilou⁵ and Ammar Almarghani^{1,*}

¹Department of Periodontics, Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia

²Department of Endodontics, Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia

³Department of Basic and Clinical Oral Sciences, Faculty of Dental Medicine, Umm Al-Qura University, Makkah, Saudi Arabia

⁴Department of Oral and Maxillofacial Surgery, Faculty of Dental Medicine, Umm Al-Qura University, Makkah, Saudi Arabia

⁵Department of Restorative Dentistry, Faculty of Dental Medicine, Umm Al-Qura University, Makkah, Saudi Arabia

Abstract:

Introduction: Robotics and Artificial Intelligence (R&AI) are now playing a significant role in influencing the future of dentistry, owing to the fast advancements in technology. The use of AI in dentistry has already begun to enhance patient care and streamline operational efficiency. However, there has been limited research exploring how dental patients perceive the adoption of R&AI.

Objective: To assess and evaluate the knowledge, concerns, and perceptions of patients agreeing to undergo treatment in its variable forms and procedures under R&AI in order to gain insight into the public understanding of such advanced technologies.

Methods: This cross-sectional study was conducted at the dental teaching hospital of King Abdul Aziz University in Saudi Arabia from July 2023 to December 2023. The subjects were dental patients from an open network and the public community in different segments, with an alternate group of ages. A digital questionnaire from Google Surveys was used. Data was analyzed using IBM SPSS version 23 (IBM Corp., Armonk, N.Y., USA).

Results: This study evaluated the perceptions of 807 participants about R&AI dental treatment. The majority, 78.3%, n = 632, reported having already encountered the term AI in dentistry; however, they had never encountered any AI-based treatment (91.9%, n = 742) and remained uninterested in seizing the opportunity (52.8%, n = 381). Around one-third of them also perceived strong disagreement with the dental performance of robotics alone (39.2%, n = 316), even if it was offered at a reduced cost compared to normal treatment (30.7%, n = 248).

Conclusion: The study's findings reveal that patients' perceptions of R&AI-assisted dental procedures remain inconsistent. While the participants show a greater willingness to embrace the use of R&AI in dental operations, their overall level of trust in R&AI is only mediocre. Patients believe it is critical for a dentist to have control over the R&AI application and take full responsibility for dental care.

Keywords: Robotic dentistry, robotic-assisted dentistry, dental artificial intelligence, dental treatment.

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*Address correspondence to this author at the Department of Periodontics, Faculty of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia; Tel: +966 (2) 6402000; Fax: +966 (12) 6404183; E-mail: mabdulhalim@kau.edu.sa

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1. INTRODUCTION

Various types of robotics and artificial intelligence (R&AI) are already playing an integral role in our daily lives and routines [1]. Robotic systems enable providers to combat fatigue, minimize error, and provide care even in remote conditions. While there are many different types of robots, they can generally be defined as “reprogrammable, computer-controlled mechanical [devices] equipped with sensors and actuators” [2]. With the current advances in modern human-safe robots, we are finally able to collaborate well enough between man and machine to the point where we can see a significant reduction in remedial and tedious tasks [3]. While at the same time, R&AI is gradually increasing in performance and driving down labour costs, becoming a more economically viable option for many different industries and fields. In the near future, these developments may even lead to advances not only in the industrial and private sectors but also in the public sector in the form of smart assistants [4].

Dentistry may be one such promising area due to the ample opportunities for different types of assistive work, automation of repetitive and tedious tasks, and support of all the different constituents of the dental team [5, 6]. For instance, the application of AI in endodontics facilitates the analysis of root canal morphology, detects root fractures, and predicts treatment outcomes [7]. Moreover, AI is making remarkable progress in the field of prosthodontics, providing many advantages that may improve patient care and teach dentistry students [8-10]. For example, a study has shown that AI has exhibited remarkable precision in predicting the debonding of CAD/CAM crowns, achieving a prediction accuracy of 98.5% [11]. This high level of accuracy enables dentists to predict possible problems and implement proactive treatments, thereby enhancing the longevity and effectiveness of dental restorations [11].

Additionally, dentists rapidly utilize AI to examine dental imaging, including radiographs and intraoral scans [12]. However, there are still many challenges that need to be overcome before the commercialization of robots and AI for daily practice in dental settings becomes the norm [13, 14]. In the healthcare industry, particularly in dentistry, patients often have a choice to determine the precise operation they want and indicate their preferences for how the process should be performed. Whether that is accomplished *via* the use of sophisticated robotic assistants and AI diagnostic help software or conventional dental methods [15]. Patients' concerns and fears may prevent them from fully accepting or seeking the use of R&AI in dentistry. In this context, it is important to understand the current consumer perception and level of acceptance of robotic dentistry [16]. R&AI is an emerging field in dentistry. However, research in this area is still sparse. Few studies have proposed the use of robotics technology in dental applications, and only a minority of published studies have reported prototype systems in the operational area [2]. Since 2016, studies on AI in dentistry have gained increasing popularity [17]. However, dental journals have only published a few studies on AI to date.

The aim of this study is to assess and evaluate the knowledge, concerns, and perceptions of patients agreeing to undergo treatment in its variable forms and procedures under R&AI in order to gain insight into the public understanding of such advanced technologies.

2. METHODOLOGY

This cross-sectional study was conducted at the dental hospital of King Abdulaziz University in Saudi Arabia from July 2023 to December 2023. The research was carried out using an online platform (Google Forms). Participants were drawn from the dental hospital's waiting areas and clinical settings who had dental appointments or were seeking dental treatments.

2.1. Inclusion Criteria

The study included adult participants aged 18 years and above who had the capacity to comprehend and respond to the questionnaire, and willingly agreed to participate in the research. Exclusion criteria: The research excluded participants under the age of 18 or those who did not declare their willingness to provide informed permission for participation.

The Raosoft online sample calculator was used to ascertain the appropriate sample size for the investigation. The optimum sample size of 780 patients was determined based on a confidence interval of 95%, a margin of error of 5%, a response distribution of 50%, and a population size of around 1500 per capita. To compensate for any missing data or incomplete replies, the sample size was increased by 10%, resulting in a total of 858 patients being asked to participate in the research.

The ethical approval was granted by the institutional advisory committee of the Faculty of Dentistry, King Abdulaziz University in Jeddah, Kingdom of Saudi Arabia (proposal No. 114-11-20).

The participants were provided with detailed consent, and their participation in the research was elective. Complete anonymity of the gathered data was guaranteed. The research team created an adapted 23-item survey for this investigation from prior comparable studies [18-21]. The questionnaire items were validated in previous studies and found valid and reliable [18, 21]. The survey had three sections of questions: demographic data (5 items), R&AI knowledge (5 items), and R&AI perceptions (8 items). The survey was piloted with 30 participants to check for structure, clarity, and language.

2.2. Statistical Methodology

This study was analyzed using IBM SPSS version 23 (IBM Corp., Armonk, N.Y., USA) and GraphPad Prism version 8 (GraphPad Software, Inc., San Diego, CA, USA) for graphical representation. Descriptive statistics were used to define the characteristics of the study variables through a form of counts and percentages for the categorical and nominal variables while continuous variables are presented by mean and standard deviations. Three scores were calculated. For calculating each score, a standard was followed by converting each question answer to points as shown below:

A simple additive method was used for each point to calculate the scores. To compare perception scores of using AI in dental treatment between groups, an independent t-test and one-way ANOVA, with the least significant difference (LSD) as a post hoc test for multiple groups, were used. These tests were done with the assumption of normal distribution. Otherwise, Games Howell for multiple groups was used as an alternative for the LSD test. For comparing variables both represented by mean a Pearson Correlation test was used. Lastly, a conventional *p*-value <0.05 was the criteria to reject the null hypothesis.

3. RESULTS

3.1. Demographics

A total of 858 participants were invited to participate in the study; 807 completed the whole survey, yielding a response rate of 94%. The research included a comparable number of male (n = 405; 50.18%) and female (n = 402; 49.81%) participants. The majority of the participants were over the age of 40 (n = 317; 39.28%). In addition, those who had a bachelor's degree accounted for 57.86% of the

participants.

3.2. Patients Knowledge and Concerns about R/AI

With regard to knowledge of R/AI dental procedures (Q1-Q5), the majority reported having already encountered the term AI in dentistry (78.3%, n = 632); however, they had never been exposed to any treatment used by AI (91.9%, n = 742) (Table 1). Since the majority of the participants experienced no robot-assisted dental treatment, more than half of them were not applicable in answering questions about AI satisfaction (68.0%, n = 549) and repeat intervention (68.6%, n = 554). Even if they were offered a free robot-assisted dental trial appointment, the majority were still not interested in grabbing the opportunity (52.8%, n = 381).

Table 2 shows the concerns of those participants who were not willing to try the treatment performed by a robot alone (Q6). The concern with the highest rate was the trust issue, followed by safety, unfamiliarity, fixation on the traditional way, high cost, uncomfortable feeling, fear of dental treatment and dissatisfaction with the result.

Table 1. Patients' knowledge of using R&AI dental procedures.

Robotics Dental Procedures		Count	%
Total		807	100.0
1) Have you ever encountered the term "Artificial intelligence" in dentistry?	No	175	21.7
	Yes	632	78.3
2) Have you ever been exposed to any kind of treatment used by AI?	No	742	91.9
	Yes	65	8.1
3) If you have been treated with a robot alone, were you satisfied with the treatment that has been provided to you?	No	141	17.5
	Yes	30	3.7
	In-between	87	10.8
	Not applicable	549	68.0
4) If you have been treated with a robot alone, would you like to go through this experience again?	Strongly agree	13	1.6
	Agree	52	6.4
	Neutral	120	14.9
	Disagree	48	5.9
	Strongly disagree	20	2.5
	Not applicable	554	68.6
5) If there was a free trial appointment with a treating robot, will you take the trial and try the experience?	No	426	52.8
	Yes	381	47.2

Table 2. Reasons for not willing to try the treatment performed by a robot alone.

6) If you are unwilling to try a treatment performed by a robot alone or do not want to go through this experience again, could you explain your concerns?	Count	%
Not applicable	401	49.7
Do not trust a machine to give the treatment	156	19.3
Safety-wise	128	15.9
It's a new thing and uncommon in our population	125	15.5
There won't be any understanding/ compassion toward the patient	124	15.4
Used to the traditional way of treatment (performed by a human)	102	12.6
It was expensive	82	10.2
You were not comfortable during the treatment	65	8.1
Fear of dental treatment in general	52	6.4
You didn't like the result of the treatment	13	1.6

When it comes to the perception of participants towards AI dental treatment (Q7-Q12), the majority strongly disagreed that the complicated procedures (*i.e.*, implant surgeries, gum surgeries, extractions, *etc.*) can be performed by robot alone (55.8%, n = 450), and that favored dentist over a robot in terms of giving better treatment (59.5%, n = 480) (Table 3). Around one-third of them also perceived strong disagreement with the dental

performance of the robot alone (39.2%, n = 316), even if it was offered at a reduced cost compared to normal treatment (30.7%, n = 248). Also, one-fourth of them had a neutral perception when simple procedures (cleaning, fillings, *etc.*) were performed by the robot alone (26.4%, n = 213). On the other hand, approximately one-third of participants strongly agreed when the dentist performed the treatment with robot assistance (32.7%, n = 264).

Table 3. The perception of participants towards AI dental treatment.

Variables		Count	%
Total		807	100.0
7) If a robot performs your dental treatment alone without the help of the dentist.	Strongly disagree	316	39.2
	Disagree	151	18.7
	Neutral	214	26.5
	Agree	74	9.2
	Strongly agree	52	6.4
8) If a robot performs your dental treatment alone without the help of the dentist, was offered at a reduced cost when compared to normal treatment	Strongly disagree	248	30.7
	Disagree	159	19.7
	Neutral	216	26.8
	Agree	118	14.6
	Strongly agree	66	8.2
9) If the procedures were simple; like non-surgical periodontal therapy, fillings performed by a robot alone without the help of the dentist	Strongly disagree	181	22.4
	Disagree	123	15.2
	Neutral	213	26.4
	Agree	159	19.7
	Strongly agree	131	16.2
10) If the procedures were complicated, like periodontal and implant surgeries, extractions (tooth removal) performed by a robot alone without the help of the dentist	Strongly disagree	450	55.8
	Disagree	144	17.8
	Neutral	135	16.7
	Agree	46	5.7
	Strongly agree	32	4.0
11) A dentist performs your treatment assisted by a robot	Strongly disagree	41	5.1
	Disagree	71	8.8
	Neutral	199	24.7
	Agree	232	28.7
	Strongly agree	264	32.7
12) If we compared AI (robot) or a dentist, who can offer better treatment results in your opinion?	The dentist	480	59.5
	The robot	42	5.2
	Same results	54	6.7
	I don't know	231	28.6

Table 4. The accepted robot-assisted dental procedures, according to the participants.

13) What are the dental procedures that you would accept to be performed on you by R&AI alone?		Count	%
Total		807	100.0
Diagnosis & treatment planning	No	301	37.3
	Yes	506	62.7
Taking radiographs (X-rays)	No	112	13.9
	Yes	695	86.1
Non-surgical periodontal therapy	No	312	38.7
	Yes	495	61.3
Bleaching (teeth whitening)	No	333	41.3
	Yes	474	58.7

(Table 4) contd....

13) What are the dental procedures that you would accept to be performed on you by R&AI alone?		Count	%
Sealants & fillings	No	552	68.4
	Yes	255	31.6
Braces	No	594	73.6
	Yes	213	26.4
Root canal treatment	No	686	85.0
	Yes	121	15.0
Extraction (Tooth removal)	No	681	84.4
	Yes	126	15.6
Periodontal and implant surgeries	No	715	88.6
	Yes	92	11.4

The accepted robot-assisted dental procedures, according to the participants, are shown in Table 4. The majority of them reported diagnosis and treatment planning (62.7%, n = 506), radiograph taking (86.1%, n = 695), non-surgical periodontal therapy (61.3%, n = 495), and bleaching teeth (58.7%, n = 474) as accepted steps that can be done by the robots towards them. However, sealants and fillings (68.4%, n = 552), braces (73.6%, n = 594), root canal treatment (85.0%, n = 686), extraction (84.4%, n = 681), and periodontal and implant surgeries (88.6%, n = 715) were not favored by the majority.

The association of the perception of AI dental treatment score against the demographic factors was then assessed (Table 5). Results revealed significant differences in the perception of AI dental treatment score relative to gender (p < 0.001) according to the Independent t-test at 0.05 level. This suggests that the said treatment is more acceptable for male than female participants. No significant differences in the perception of AI dental treatment scores (p > 0.005) were found with respect to the rest of the demographic characteristics.

Table 5. The association of perception of AI dental treatment score against the demographic factors.

Demographics		Total	Perception of AI Dental Treatment Score	p-value
1. Gender	Male	405	14.16 ± 4.8	<0.001 ^a
	Female	402	12.36 ± 4.6	
2. Age	18 - 21 YO	161	13.11 ± 4.4	0.592
	22 - 30 YO	188	12.87 ± 4.2	
	31- 40 YO	141	13.42 ± 5.4	
	41+ YO	317	13.43 ± 5.0	
3. Nationality	Non-Saudi	63	12.51 ± 4.6	0.191
	Saudi	744	13.33 ± 4.8	
4. Level of education	Undergraduate (High school) level	127	13.95 ± 4.3	0.079
	Bachelor's (college) level	467	12.96 ± 4.7	
	Postgraduate (Master & Doctorate) level	213	13.51 ± 5.1	
5. Occupation	Staff in health sectors, either private/ governmental (Physician, dentist, nurse)	137	13.14 ± 4.3	0.320
	Staff in private companies (Business, marketing, financing)	118	13.19 ± 5.0	
	Staff in governmental facilities (Business, marketing, financing)	61	13.62 ± 5.3	
	Unemployed	274	13.21 ± 4.5	
	Employed	38	15.13 ± 4.9	
	Retired	143	12.97 ± 4.7	
Other	36	12.94 ± 6.4		

Note: ^a-significant using Independent t-test @<0.05 level.

Table 6. AI dental procedure acceptance score.

Correlations		Perception of AI Dental Treatment Score
Dental Hygiene Score	r	0.056
	p-value	0.111
	N	807
Rate your level of fear/ anxiety toward dental treatment?	r	0.012
	p-value	0.743
	N	807

(Table 6) contd.....

Correlations		Perception of AI Dental Treatment Score
AI Dental Procedure Acceptance Score	r	0.599**
	p-value	<0.001
	N	807

Note: **. Correlation is significant at the 0.01 level (2-tailed).

Table 7. AI dental treatment score with respect to the knowledge, satisfaction and perception of the participants.

Variables	Total	Perception of AI Dental Treatment Score	p-value	
Knowledge				
Have you ever encountered the term "Artificial intelligence" in dentistry?	No	632	13.18 ± 4.7	0.318
	Yes	175	13.58 ± 4.9	
Have you ever been exposed to any kind of treatment used by AI?	No	742	13.12 ± 4.7	0.004 ^a
	Yes	65	14.88 ± 5.1	
Satisfaction				
If you have been treated with a robot alone, were you satisfied with the treatment that has been provided to you? ^d	No	141	12.54 ± 4.7 ^A	<0.001 ^b
	Yes	30	18.27 ± 4.6 ^B	
	In-between	87	14.94 ± 3.7 ^C	
	Not applicable	549	12.91 ± 4.7 ^A	
Perception				
If you have been treated with a robot alone, would you like to go through this experience again? ^d	Strongly agree	13	19.54 ± 5.7 ^A	<0.001 ^b
	Agree	52	17.94 ± 3.5 ^A	
	Neutral	120	13.80 ± 3.8 ^B	
	Disagree	48	12.63 ± 3.7 ^B	
	Strongly Disagree	20	7.75 ± 2.2 ^C	
If there was a free trial appointment with a treating robot, will you take the trail and try the experience?	No	426	10.92 ± 4.1	<0.001 ^a
	Yes	381	15.88 ± 4.1	
If we compared AI (robot) or a dentist, who can offer better treatment results in your opinion? ^c	The dentist	480	12.09 ± 4.4 ^A	<0.001 ^b
	The robot	42	18.60 ± 3.9 ^B	
	Same results	54	16.83 ± 4.4 ^B	
	I don't know	231	13.91 ± 4.5 ^C	

Note: ^a-significant using Independent t-test @<0.05 level.

^b-significant using One-Way ANOVA Test @<0.05 level.

^c-Post hoc test = LSD

^d-Post hoc test = Game-Howell.

In terms of the AI dental procedure acceptance scores of the participants, a two-tailed correlation analysis showed a strong positive correlation ($r = 0.599$) between the perception of the AI dental treatment score and the AI dental procedure acceptance score (Table 6). This implies that the participants are more inclined to accept robot assistance as part of dental procedures.

Lastly, the association of perception of AI dental treatment score with respect to the knowledge, satisfaction and perception of the participants was also evaluated, as shown in Table 7. The majority of the participants have never been exposed to dental treatment (13.12 ± 4.7) and they are willing to go through the experience again (19.54 ± 5.7); however, they think dentists can offer better treatment (12.09 ± 4.4).

4. DISCUSSION

In the present study, patients' perspectives on the introduction of R&AI systems in dental care have been

studied. It was intriguing to find out that patients were already familiar with the term AI in dentistry applications. Prior research has shown that patients are progressively gaining knowledge about the significance of artificial intelligence (AI) and robots in the field of healthcare [16, 20]. This phenomenon may be attributed to the increasing prevalence of artificial intelligence (AI) technologies among the general population [22]. The rapid advancement of technology has played a critical role in AI's ascent. AI systems are becoming more complex and powerful as technology advances, resulting in greater knowledge acquisition and wider acceptance. Moreover, AI-powered devices are becoming more and more integrated into people's everyday lives and experiences via voice assistants, recommendation algorithms, and tailored content delivery [22].

Another significant finding is that almost half of the patients (52.8%, $n = 381$) showed a lack of interest in availing themselves of the chance to undergo robot-

assisted dental treatment. The possible explanation is that although there has been an increase in studies on the use of robots in dentistry in recent years, the available information about the efficacy of robot-based therapy remains limited. Several studies failed to address all categories of deficiencies related to accessibility, structure, comprehensiveness, and the value and utility of these solutions in dental practice [13].

Moreover, the primary worry that had the most frequency was the problem of trust, followed by concerns over safety, unfamiliarity, adherence to conventional practices, high expenses, discomfort, fear of dental procedures, and dissatisfaction with the final result. This finding is consistent with the results of the prior reports and investigations [13, 23]. According to Khullar *et al.*, the primary issues raised by patients about the use of artificial intelligence (AI) in healthcare were misdiagnosis, privacy breaches, and increased healthcare expenses [23].

In relation to patients' perceptions towards R & AI in dental treatment, a significant portion of respondents (55.8%, $n = 450$) reported discomfort during complex procedures such as dental implants and tooth extraction. Conversely, a smaller proportion (26.4%, $n = 213$) expressed a neutral opinion when robots were involved in simpler procedures like cleaning and fillings. These findings align with current research that suggests varying opinions on the use of AI in certain healthcare environments [23, 24]. Furthermore, a majority of participants demanded a declaration of using AI in their own medical treatments [23, 24]. The fact that dentistry has not fully embraced AI technology in its daily operations may justify these views. The availability and accessibility of dental data in the field of R & AI are limited compared to other types of data, mostly owing to concerns around data privacy and organizational obstacles. In dental AI research, the process of measuring and evaluating outcomes is often lacking in replicability and robustness [13]. Furthermore, the results of artificial intelligence in dentistry are sometimes not immediately practical [13]. The little data offered by the majority of current dental AI applications can only provide limited guidance for the intricate decision-making process in clinical treatment [13].

The robot-assisted dental procedures that were most well accepted by patients were diagnostic and treatment planning (62.7%, $n = 506$) and radiograph taking (86.1%, $n = 695$). The outcome was fascinating, with the majority of patients expressing a preference for robots for carrying out non-invasive dental operations. Prior reviews claimed that AI algorithms have the ability to rapidly examine extensive patient data, such as X-rays and medical histories [1, 25]. AI, especially with deep learning (DL), is becoming more prominent [1, 25]. Deep learning algorithms can examine cone beam computed tomography (CBCT) images and intraoral X-rays to detect and classify anatomical characteristics such as teeth, absence of teeth, bone levels, apices, and restorations, thereby aiding in the diagnosis and treatment planning process [1, 25].

The current research revealed a significant gender

disparity in the acceptance of robots and AI therapy, with male participants showing higher levels of acceptance compared to female participants ($p < 0.001$). The findings were intriguing and consistent with other research that has shown disparities in the comprehension and conceptualization of the robot-assisted surgical procedure between males and females [26]. One possible explanation could be that females may be more concerned about the accuracy of artificial intelligence in the field of medicine. According to a poll conducted by the Pew Research Center in the USA, a majority of women (66%) expressed discomfort with their healthcare practitioner depending on AI for their medical treatment, whereas a smaller proportion of men shared this sentiment [27]. Furthermore, another study examined the perception of AI in medicine among the general public and revealed that males demonstrated greater confidence in AI compared to females [28]. Another potential rationale is that females may exhibit more worry over the ethical implications and privacy concerns associated with the use of such technological advances. A study was conducted to examine the perspectives and readiness of experienced dentists and undergraduate students towards the integration of AI in dental practice. The study revealed that female dentists had a greater awareness of ethical concerns associated with AI implementation compared to their male counterparts [29].

5. LIMITATIONS

As far as the authors are aware, this study is among the first to examine patients' perceptions of the use of R&AI in dental treatments. Furthermore, the participants were selected from a prominent dental teaching hospital located in the western area of Saudi Arabia. Consequently, the hospital caters to a wide range of patients, making it well-suited for gathering a diversified survey group. Nevertheless, it is important to refrain from making broad generalizations based on the results of cross-sectional research due to their inherent limitations. Additionally, the inherent structure of closed-ended surveys may restrict participants' ability to provide comments or ideas. It is desirable for future research to include several hospitals in numerous cities in order to gain a more thorough insight into dental patients' knowledge and use of R and AI. Moreover, this study relies on patients' subjective self-understanding of dental procedures without providing a clear definition of a particular clinical phase, which may affect their response to questions. Future studies could potentially address this issue by explaining more details about specific dental treatments. Lastly, there are a limited number of validated tools to evaluate patients' perceptions of technology in healthcare, particularly AI. Therefore, the study used questionnaires from previously published research. Subsequent investigations should endeavour to validate these findings.

6. CLINICAL IMPLICATIONS

Unfortunately, the majority of interdisciplinary research in the field of AI combining engineering and dentistry focuses on implantology, although the invasive

nature of this application may impair the acceptance of this technology among patients and dentists. Hence, these most invasive applications are less suitable than their forerunners. Therefore, research in the field of assistive robotics seems to be more promising to facilitate the introduction of this new robotic-enabled era [30]. Additionally, research on educational robotics in university environments appears to be a promising starting point for introducing dental AI and paving the way for future dentists to accept robots [31].

Another important point to mention is the effort required of dentists and dental assistants in order to learn to work with these new technologies. Older generations may be more accustomed to familiar tools and are more skeptical about adapting [32]. However, new generations of dentists can be considered digital natives, and their experience might lead them to use digital tools more naturally. Moreover, in light of the expected developments in robotics and AI, future generations may even be considered "robonatives," as defined by Haddadin *et al.* [33]. Because of its frequent use of digitized images and electronic health information, dentistry is a good subject for deploying virtual AI algorithms. While there is a lot of talk about how AI could change dentistry, there are also doubts about whether AI will eventually replace dentists. Modern AI is particularly good at using structured knowledge and extracting information from large data sources. However, it is unable to create associations in the same way that the human brain does and can only make partial, complex decisions in a clinical situation [25]. On the other hand, there are numerous approaches in the research community to explore the potential and challenges of integrating robotics into dentistry; thus, the speed of innovation in this novel field should increase in the next few years.

CONCLUSION

The study's findings reveal that patients' perceptions of R&AI-assisted dental procedures remain inconsistent. While the participants show a greater willingness to embrace the use of R&AI in dental operations, their overall level of trust in R&AI is only average. Patients believe it is critical for a dentist to have control over the R&AI application and take full responsibility for dental care. The clinical significance of this study's findings can be summarized as follows:

- Dentists must allocate sufficient time to explain to patients the advantages and precautionary measures linked to the use of R&AI in dental procedures.
- Establishing trust entails engaging in transparent communication, attentively addressing any concerns, and ensuring that patients feel acknowledged and respected.

AUTHOR'S CONTRIBUTION

N.N.D. and Y.A.: Study conception and design were contributed; A.A. H.A., R.S. and A.A.: Data were collected and manuscript draft was provided.

ABBREVIATION

R&AI = Robotics and Artificial Intelligence

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The ethical approval was granted by the institutional advisory committee of the Faculty of Dentistry, King Abdulaziz University in Jeddah, Kingdom of Saudi Arabia (proposal No. 114-11-20).

HUMAN AND ANIMAL RIGHTS

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committees and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from the participants.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIAL

All data generated or analysed during this study are included in this published article.

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CONFLICT OF INTEREST

The authors declared no conflict of interest, financial or otherwise.

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