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Artificial Intelligence In Dentistry: Transforming Oral Surgical Planning And Patient Management

Abstract
Artificial intelligence (AI) has emerged as an important technological advancement in dentistry, contributing to improvements in diagnosis, oral surgical planning, treatment efficiency, and patient management. The integration of AI-assisted systems in dental practice has enhanced clinical precision and supported evidence-based decision-making. The present study aimed to assess the awareness, perception, and acceptance of AI in oral surgical planning and patient management among dental professionals. A cross-sectional questionnaire-based study was conducted among 80 participants, including dental practitioners, oral surgeons, and postgraduate dental students. Data were collected using a structured self-administered questionnaire distributed through online and offline modes. The questionnaire included demographic details and Likert scale-based questions related to awareness of AI, oral surgical planning, patient management, and challenges associated with AI adoption. The collected data were analyzed using Microsoft Excel with descriptive and inferential statistical methods. The study findings demonstrated generally positive awareness and perception regarding AI applications in dentistry. Most participants agreed that AI improves diagnostic accuracy, treatment planning, implant placement precision, patient communication, and record management. However, challenges such as high implementation cost, lack of technical expertise, and data privacy concerns were identified as major barriers to AI adoption. AI has significant potential to improve oral healthcare by enhancing clinical efficiency, surgical precision, and patient-centered care. Increased professional training and technological support are necessary for successful integration of AI in dentistry.

1. INTRODUCTION

In the medical field, artificial intelligence (AI) has become a significant breakthrough in technology and is now having a great impact on today's dentistry. AI is the application of computer systems that can learn, reason, interpret and analyze information, and make clinical decisions, which traditionally were the work of humans. Within dentistry, AI-driven technologies are increasingly employed to increase the precision of diagnosis, treatment planning, efficiency of workflow and patient management [2]. The pace at which digital dentistry has evolved has helped to push forward the integration of AI in various dental fields. Radiographic interpretation, disease detection, implantology, orthodontics, prosthodontics, and oral surgery are areas where AI is increasingly being employed in the dental field. These technologies help physicians to efficiently process vast amounts of medical data, while minimizing the risk of diagnostic and procedural error [2]. Moreover, the fusion of AI, robotics, 3D printing, and virtual surgical planning has revolutionized the field of oral health and surgical practices [3].

AI has brought a number of advancements that have enhanced the accuracy and predictability of dental treatments. The application of AI techniques, including

machine learning and deep learning, will enable physicians to detect any abnormalities in the mouth, radiograph analysis, and the creation of tailor-
made treatment plans for patients. Patient care is also aided through increased clinical productivity and evidence-based decisions made through the use of AI [4]. Artificial Intelligence (AI) is being utilized in oral surgery to enhance outcomes and minimize human errors [5]. Clearly the use of AI in this facet of healthcare holds much promise for patient care. AI based intelligent software programs can be used for effective patient education, record keeping, appointment booking and follow up of patients. Other AI based systems can analyze a patient's data and give treatment ideas that will maximize patient satisfaction and involvement [6]. Over time it seems AI should revolutionise dental healthcare.

Significant developments have occurred in the application of AI in dentistry Recently. The early use of AI was restricted to computerised record keeping and imaging software but modern AI technology now enables diagnosis and treatment in all branches of dentistry [7]. AI-driven advancements have enhanced the precision of interpreting radiographs, automated disease diagnosis, and optimized healthcare delivery, among other benefits, while minimizing clinical burdens and treatment delays [8]. Multiple research papers have pointed out the modern relevance of AI in reshaping the conventional dental practice. Currently, AI technologies are being applied in restorative dentistry, prosthodontics, implantology, and oral pathology for simulation, digital impressions, and computer-guided procedures respectively [9]. These technologies also benefit clinical decision-making by offering data analysis and predictive evaluations enhancing the efficiency of treatment planning and patient management for dentists [10].
Robotic-assisted systems and AI-driven surgical navigation have shown significant promise in the field of oral implantology and prosthodontics, where they help to enhance the accuracy of the procedures and decrease complications. The surgical planning using computer assisted techniques enables the surgeon to carry out procedures with less invasiveness and higher accuracy and predictability [11]. Furthermore, new AI tools like ChatGPT and LLM are being investigated to provide patient counseling, patient communication, and digital healthcare support in dentistry [12].

Despite the ongoing progress in AI, there are several obstacles for the application of this technology in dentistry. Among the factors hampering the adoption of AI are its high costs, lack of technical expertise, ethical issues, and data privacy. Furthermore, certain medical experts voice their apprehension to the use of automated systems, and the potential loss of clinical judgment in patient care. With the increasing importance of AI in the dental and oral surgery fields, it is necessary to assess the awareness and perception of dental professionals about the technologies. Knowing attitudes of professionals with regard to AI-assisted systems could lead to a better understanding of obstacles to implementation and inform future educational and technological advancements in dentistry. Hence, the current study was undertaken to evaluate the awareness, perception, and acceptance of AI in the context of oral surgical planning and patient management by dental professionals.

1.1 Objectives of the Study
1.To assess the awareness of AI applications in dentistry among dental professionals.
2.To evaluate the perception of AI-assisted oral surgical planning and patient management.
3.To identify the challenges and acceptance associated with the adoption of AI in dental practice.

2. Materials and Methods
2.1 Study Design and Setting
The objective of this study was to evaluate the awareness and perception of dental professionals regarding the use of AI (AI) in oral surgical planning and patient management in a cross sectional questionnaire based survey. The study was conducted in dental colleges, private clinics and hospitals for a period of three months.

2.2 Sample Size and Sampling Technique
The number of participants of the study was 80 subjects obtained by convenience sampling method. The participants were chosen by availability and willingness to participate in the survey.

2.3 Inclusion and Exclusion Criteria
All of the registered dental practitioners, oral surgeons, and postgraduate dental students who gave informed consent were included in the study. Students from the undergraduate level, those who did not consent to the studies, and students who did not complete the questionnaires were excluded from the study.

2.4 Data Collection Tool
Structured self-administered questionnaire was used to collect data, which was developed after a thorough literature survey on the use of AI in dentistry and oral surgery. The questionnaire had four sections covering demographics, awareness of AI in dentistry, AI in oral surgical planning, patient management and challenges with AI implementation. A 5-point Likert scale from “Strongly Disagree” to “Strongly Agree” was used to record responses.

2.5 Data Collection Procedure
The questionnaire was handed out in the form of Google Forms and printed forms. The purpose of the study was explained to the participants and informed consent was obtained prior to their participation. Privacy and anonymity of the answers were respected during the study.
2.6 Ethical Considerations
Prior to the study, ethical approval was obtained from the Institutional Ethics Committee. Participation was voluntary and no information collected was used for purposes other than research and participants' confidentiality was ensured.

2.7 Statistical Analysis
Data were collected, processed and analyzed in the Microsoft Excel spreadsheet. Frequency, percentage,

mean and standard deviation were calculated for descriptive statistics. The Chi-square test and independent t-test were used for inferential analysis, and a p-value of less than 0.05 was considered statistically significant.

3. Results

3.1 Demographic Characteristics

In the present study, 80 participants in various dental practices and academic institutions were included. Respondents were from a wide age range, and across a variety of professional qualifications and clinical experience, offering a broad picture of attitudes towards AI in dentistry. There were male and female participants, post-graduate dental students and working dentists as well. Table 1 summarizes the demographic information of the participants.

Table 1. Demographic Characteristics of Study Participants (n = 80)

Variable	Category	Frequency (n)	Percentage (%)
Age	20–25 years	22	27.5
	26–30 years	19	23.8
	31–35 years	25	31.3
	Above 35 years	14	17.5
Gender	Male	28	35.0
	Female	30	37.5
	Prefer not to say	22	27.5
Qualification	BDS	20	25.0
	MDS	16	20.0
	Postgraduate Student	13	16.3
	Oral Surgeon	31	38.8
Years of Experience	Less than 1 year	26	32.5
	1–5 years	18	22.5
	6–10 years	15	18.8
	More than 10 years	21	26.3

The gender-wise distribution of participants is illustrated in Figure 1.

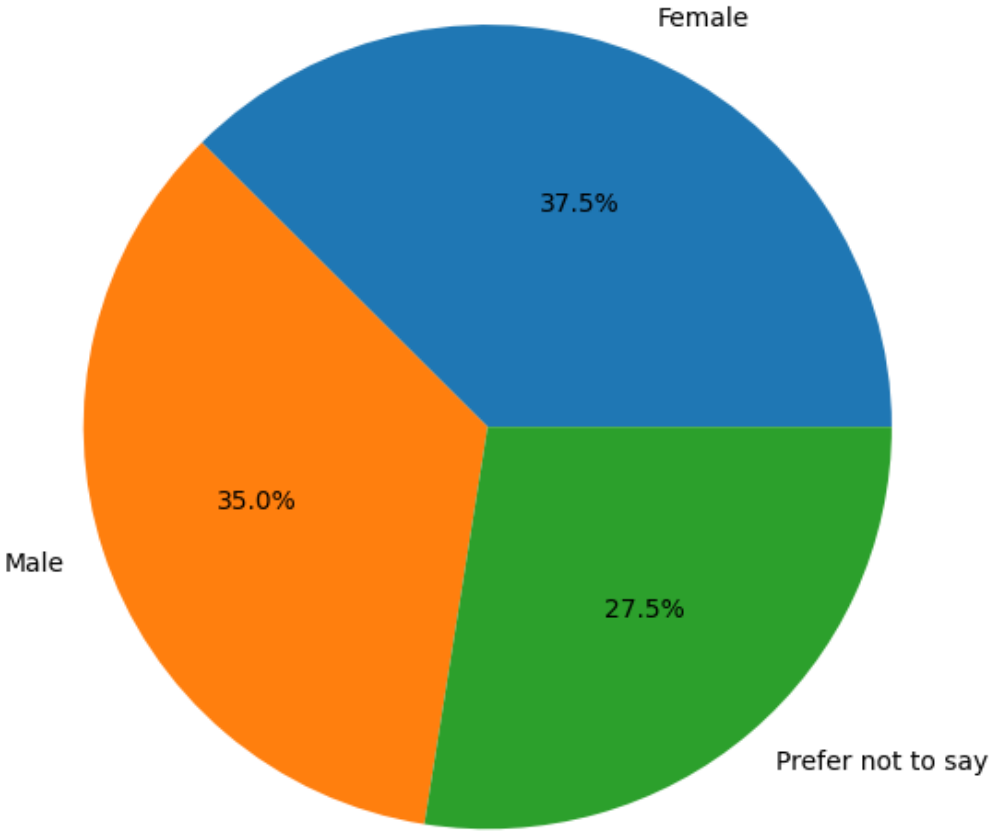

Figure 1. Gender distribution of study participants

As shown in the figure, the respondents are fairly balanced in gender with the largest percentage being female, with male participants following and respondents who did not want to disclose their gender following that.

3.2 Awareness Regarding AI in Dentistry

Results indicate that there was positive awareness regarding AI and its application in dentistry among the participants. The vast majority of the participants were aware of the growing role of AI in contemporary dental practice and acknowledged that AI technologies improve the accuracy of diagnoses and increase clinical efficiency. Additionally, the participants had positive attitudes toward incorporating the notion of AI in dental education and training programs. The descriptive statistics pertaining to AI awareness in dentistry are provided in Table 2.

Table 2. Awareness Regarding AI in Dentistry

Variable	Mean ± SD
Familiarity with AI in dentistry	3.89 ± 1.16
Importance of AI in modern dental practice	4.12 ± 1.01
AI improves diagnostic accuracy	3.92 ± 1.10
AI useful in radiographic interpretation	3.68 ± 1.19
AI improves treatment planning efficiency	3.78 ± 1.14
AI should be included in dental education	4.03 ± 1.06

The mean awareness scores related to AI in dentistry are illustrated in Figure 2.

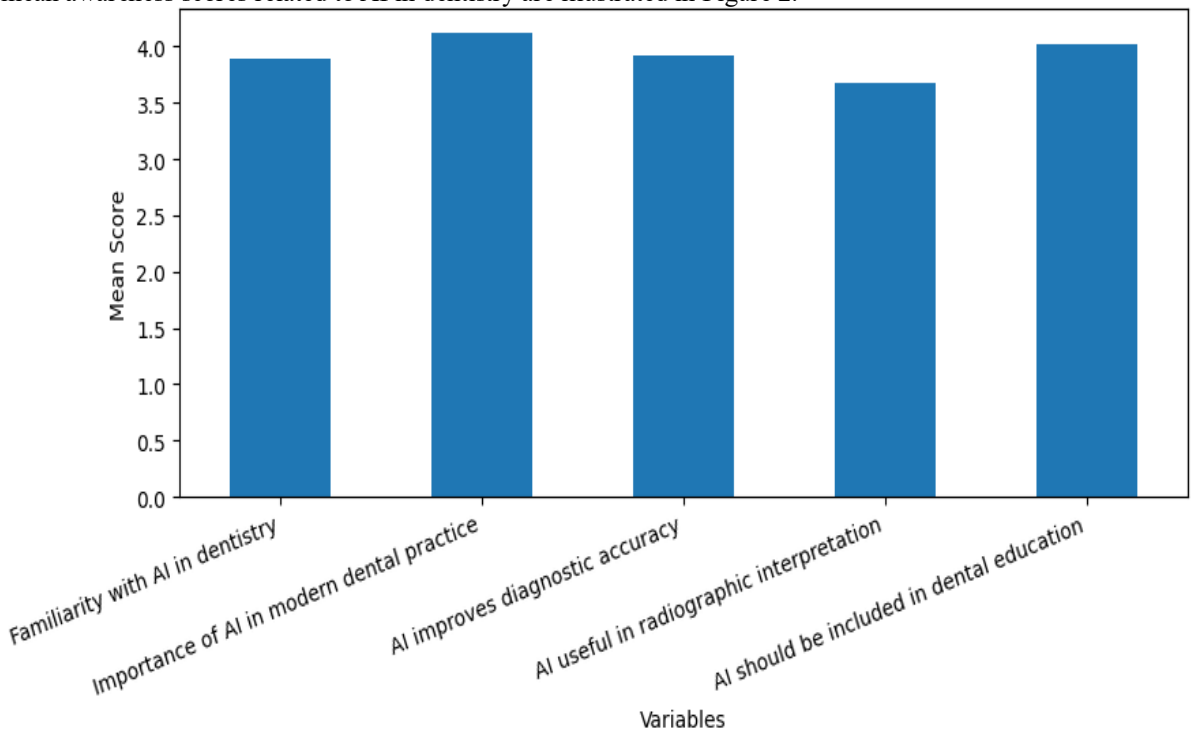

Figure 2. Awareness regarding AI in dentistry

Figure 2 depicts that the respondents had comparatively high average scores in domains such as the significance of AI in dentistry, diagnostic precision, and use of AI in dental education, indicating a high level of awareness among the respondents.

3.3 Perception of AI in Oral Surgical Planning

In general, there was a positive attitude towards the use of AI in the planning process for oral surgeries. It is believed by the participants that the use of AI-based technology can assist in creating more accurate treatment plans, proper placement of implants, and avoiding errors. Furthermore, several participants agreed that the use of AI would enable the prediction of problems during surgery and would increase the efficiency of surgery procedures. The scores in detail perception are presented in Table 3 below.

Table 3. Perception of AI in Oral Surgical Planning

Variable	Mean ± SD
AI helps accurate oral surgical planning	3.90 ± 1.11
AI reduces human errors	3.85 ± 1.13
AI improves implant placement precision	3.95 ± 1.08
AI predicts surgical complications	3.72 ± 1.20
AI improves treatment planning efficiency	3.78 ± 1.14

The mean perception scores related to AI-assisted oral surgical planning are illustrated in Figure 3.

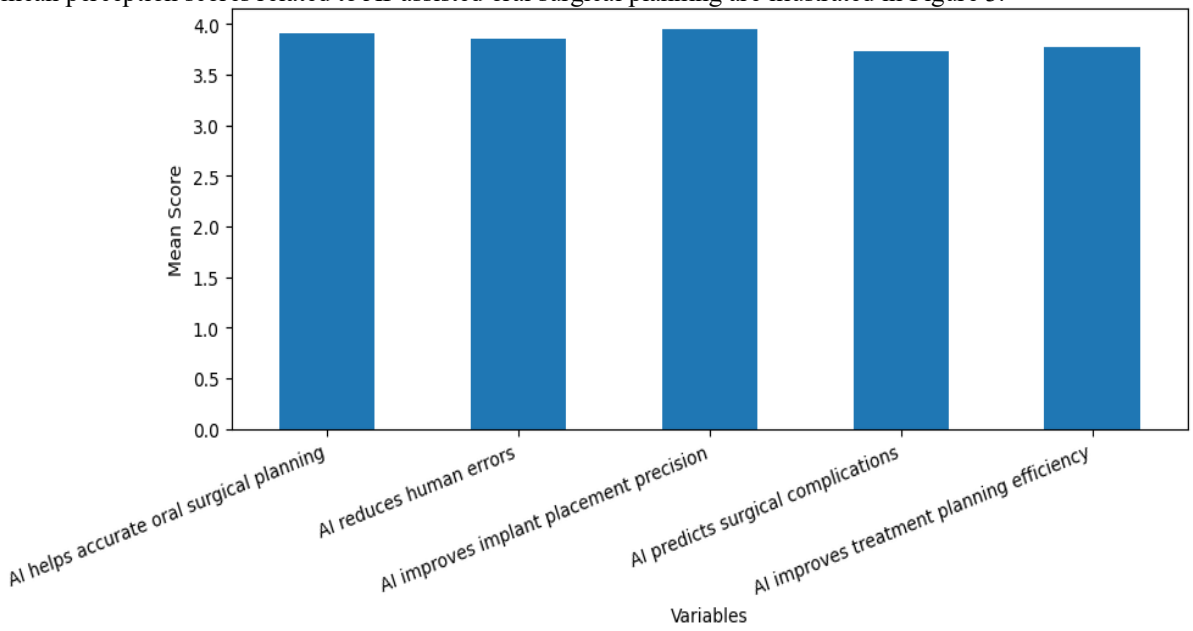

Figure 3. Perception of AI in oral surgical planning

3.4 Role of AI in Patient Management

The outcomes showed that the participants found AI to be a valuable tool for enhancing the management of patients in the dental field. Patient communication, record maintenance, treatment personalization, and patient satisfaction were variables that had positive responses. AI technologies were seen as a positive addition to improve workflow efficiency and enable patient-centred care. Based on these results, it can be inferred that aside from its clinical value, AI can also enhance the overall experience of patients in dental care practices. Table 4 shows the responses for patient management.

Table 4. Role of AI in Patient Management

Variable	Mean ± SD
AI enhances patient communication and education	4.00 ± 1.02
AI improves patient record management	3.86 ± 1.15
AI supports personalized treatment	3.88 ± 1.09
AI improves patient satisfaction	3.94 ± 1.04
Willingness to use AI in future practice	3.75 ± 1.12

The mean scores related to AI applications in patient management are presented in Figure 4.

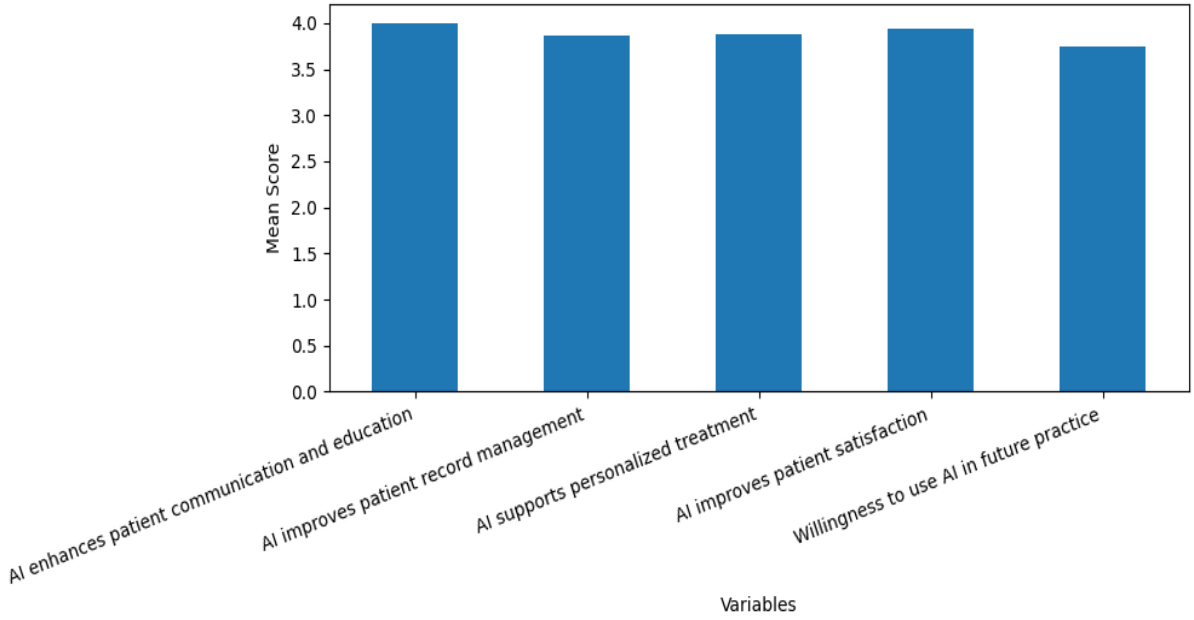

Figure 4. Role of AI in patient management

Figure 4, shows that overall, there are consistently high mean scores for all patient management variables, reflecting positive attitudes about the use of AI to enhance patient-centred dental care and the efficiency of clinical workflows.

3.5 Challenges Associated with AI Adoption

Respondents showed positive attitudes towards the integration of AI, however several limitations and concerns about the implementation of AI were identified. Financial shortcomings, lack of technical expertise, and data privacy concerns were viewed as significant obstacles for the adoption of AI in dentistry. A few respondents also raised the concern of excessive reliance on AI systems, which might impact clinical judgment. However, participants agreed as a whole that AI will most likely be a part of the future of dentistry. Table 5 summarizes some of the key problems in using AI.

Table 5. Challenges Associated with AI Adoption in Dentistry

Variable	Mean ± SD
Lack of technical training is a barrier	3.88 ± 1.07
High-cost limits AI use	3.95 ± 1.10
Data privacy and security concerns	3.80 ± 1.12
AI may reduce clinical judgment	3.91 ± 1.15
AI will transform dentistry in future	3.81 ± 1.09

3.6 Statistical Association

The correlation between professional qualification and the intention to use AI technologies in the future profession of dentistry was analysed. The statistical results showed that there was no significant correlation between qualification level and AI acceptance. Although there was no statistical significance, the general attitudes of the respondents towards the use of AI in dentistry were positive across all the professional groups. Table 6 shows the results of statistical analysis.

Table 6. Association Between Qualification and Willingness to Use AI

Statistical Test	Chi-square Value	p-value	Interpretation
Qualification vs Willingness to Use AI	15.38	0.221	Not statistically significant

4. Discussion

The main objective of the current study was to evaluate the awareness, perception, and acceptance of dental professionals on the use of AI in the domain of oral surgery. It was found that there was an overall favorable attitude in favor of the implementation of artificial intelligence in the field of dentistry with respect to its use in improving diagnosis, surgeries, and planning along with patient care. The significance of the role of AI is felt greater than before as it could enhance the efficiency and patient care in clinical practice. The age bracket of the study sample comprised of people with different extent of experience with clinical practice. The broad cross section sampled gave a varied opinion as to how AI could be utilized in dentistry. Majority of the participants expressed a positive outlook as for their knowledge AI enabled devices, and would be hopeful of improved diagnostics and treatment planning using AI. These findings are in conformity with the findings of earlier studies, reflecting the ongoing digital revolution in dentistry due to sophisticated technologies [13].

It was discovered during the current study that there is positive perception on the application of AI to the oral surgical planning. All participants agreed that AI-based systems are capable of increasing the accuracy of placing implants, preventing surgeries from making errors, and predicting possible complications during the surgery. In line with this, Shan et al. observed that AI-based tools for diagnostics and planning are highly influential in dentistry due to their high precision and decision-making ability [14]. Moreover, advancements in AI-based IoT systems and digital treatment planning have contributed to enhancing the safety of the process [15].

Another finding that emerged from the current research is the importance of AI in enhancing the management of patients. The respondents believed that AI-based technology could improve certain areas of patient management including patient communication, documentation, personalization of treatment, and patient satisfaction. This observation is consistent with the findings of previous research which revealed the potential of AI-based systems in optimizing patient management and clinical processes [16]. AI-based technology has also been reported to improve access to healthcare services and administrative efficiency and reduce the workload of dentists [17]. Furthermore, the findings also showed an increased trust and confidence by dental practitioners in the use of artificial intelligence tools along with their traditional clinical abilities. AI coupled with clinical skills has been suggested to improve oral disease diagnosis and treatment outcomes [18]. Similarly, the use of artificial intelligence technology in the field of prosthodontics and restorative dentistry has proven to be highly effective [19]. This study revealed positive perceptions about the contribution of AI to dental surgery planning and education. Some of the improvements may have been attributed to the latest innovations in cone-beam computed tomography, augmented reality, virtual reality, and AI-based navigation techniques that support preoperative assessment and training in dentistry [20]. The participants also highlighted the benefits of AI in educating and communicating with patients, which aligns with the results of previous studies on how AI can help patients understand their condition better and facilitate clinical communication [21]. On to the present research, Obviously from that the respondents have positive attitudes toward the use of AI technology but some

barriers should be considered before putting it into practice in dentistry. These were the sum of financial costs, the lack of knowledge, ethical and data privacy concerns. These barriers were identified in another articles as potential risks in using AI in Dentistry [22]. Although the benefits from using AI are many from the clinical point of view, its effective implementation depends on proper infrastructure, preparation, and applications of ethical principles. The present research identified the positive attitudes of the participants for the future application of AI in Dentistry. The potential of AI in transforming the future of the area of restorative dentistry, oral surgery, implantology and patient care, aided by sophisticated predictive and intelligent clinical tools can be observed [23]. Also, as mentioned in the previous studies, AI is reported to have shown the potential to move beyond digitalization [24]. AI usage is expected to expand much more in dentistry over the next years. Previous studies have evidenced that AI systems usage has facilitated the diagnosis process, allowed efficient planning of treatments and management of the clinical workflow in dental clinics [25]. The results of this study support the ongoing interest of dentists in the application of AI systems and embody the need to include knowledge about them in dental curricula.

Even so, there are some limitations in this study and needs to be carefully used for interpretation of the result. Firstly, the present study is limited by sample size, the population studied and the results may not be extended to other populations. Secondly, the results were collected based on self-report and bias may exist while being interpreted. Lastly, the study was cross-sectional which did not allow the behavior and attitude of the population being assessed over the time. Larger sample size and multi-center studies can be performed to include dental professionals from different areas and from various specialties. The study can be also be done on application of A.I in the medical field, effect on healthcare, patients and using this technology in the health industry. Efficiency, ethic and cost-benefit advantage of A.I. use in dentistry would give more indication to its clinical value.

5. Conclusion

Artificial intelligence (AI) is transforming the world of modern dentistry today making diagnoses, planning treatment, practicing oral surgery and managing dental practices better than ever before. Overall, the research results showed that there were very positive attitudes and levels of awareness among dental professionals on the use of ai in modern dentistry. Majority of the respondents were aware of that the use of AI technologies can aid having more accurate surgeries, minimized human errors, aids communication with patients, and while being able to achieve sound clinical decisions. Moreover, the survey showed an increased trend of the application of AI in oral surgical planning and patient-centered dentistry. The participants appreciated the importance of AI in the analysis of radiographs, implant planning, treatment approaches for patients, and documentation. Although these are good impressions, there are important hurdles that need to be considered when thinking of implementing AI in dentistry; the high cost of implementation, the lack of technical knowledge and the issue of data privacy. To conclude, this paper shows the enormous potential of artificial intelligence in improving dental practice along with the assistance of healthcare professionals. Education and technology infrastructure are two of the most important aspects needed to integrate the AI successfully. As time goes on and technology develops further, AI is likely to become more integrated into the world of dentistry, providing even greater benefits than today.

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