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Examining how Al can enhance diagnostic accuracy, treatment planning, and patient care in dental practices. A Retrospective Cohort Analysis study.

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Abstract

Background: In this article we will explore how Advanced Intelligent Systems (AIS), specifically Artificial Intelligence (AI), are becoming fundamental in dental practice, and for improving diagnosis, treatment planning and, most importantly, patient care. One of the major advantages of applying AI is the analysis of large amounts of data and identification of patterns, which will be valuable to overcome the issues in traditional dentistry, such as relatively low accuracy of diagnostics, and insufficient time required to develop an effective treatment plan.

Objectives: the purpose of this work will be to identify how the contemporary approaches in artificial intelligence are utilized in the dental practices to raise diagnostic accuracy, as well as the quality of treatment and patient experience.

Study design: A Retrospective Cohort Analysis study.

Duration and place of study. This study is conducted in Dental section WATIM Medical and Dental College Rawalpindi from 05-jan 2021 to 05-july 2021

Methods: This study is conducted in WATIM Medical and Dental College Rawalpindi from 05-jan 2021 to 05-july 2021.The following Study categories were included: machine learning algorithms, computer-aided diagnosis, and AI-treatment planning. The diagnostic accuracy, therapeutic efficacy, and shifts in patient management were assessed by analyzing the data collected.

Results: out of 200 patients Application of the diagnostic aids under the support of artificial intelligence increased the diagnostic accuracy in caries up to 20% (SD = 5%, $p < 0.01$) compared to the usage of traditional techniques. For the 200 patients, the new treatment planning algorithms achieved a mean of 25% reduction in the time taken to complete the treatment and a mean of 15% increase in the succes rate (SD = ± 8%, SD = ± 6% respectively, $p < 0.05$). From the above conclusions, implementation of AI into dental practices offers a high determinant of benefiting dental treatments and outcomes of patients.

Conclusion: The use of AI has been proven in dental practices to enhance diagnosis, enhance the planning of patient treatment, and enhance the quality of patients' care. AI in dentistry is a trend that gives the profession a chance to develop and become more accurate when helping both the dentist and the patient.

Keywords: Machine learning, diagnostic precision, dentistry, therapy planning.

Introduction

A revolution that is currently taking place through the integration of Artificial Intelligence (AI) in almost all sectors of healthcare is also taking dentistry. There is no universal definition of AI, but it describes a class of technologies that make a system emulate human intelligence in perceiving the environment and making decisions [1]. AI is most prominently employed in dentistry to improve the precision of diagnoses and of the determination of courses of treatment, and in the provision of patients' continual care. The use of artificial intelligence in dental practice can be of great benefits and cause radical changes in the diagnosis and treatment of oral health conditions. Dental diagnosing especially the diagnostic tools usually depends on the experience and the ability of the clinician which makes the results to be less impartial. Ambulatory variation is especially calamitous in complicated situations whereby a minor variation of clinical approach or review of images can lead to disparate conclusions and decisions [2]. They contribute to the theory that AI , with the capability of sorting copious amounts of data and the capacity to identify patterns which the naked eye cannot see, may soon prove to be the answer to these difficulties. The subfield of artificial intelligence or AI is machine learning, which involves exposing such systems to large amounts of data in the form of images, records and treatments' outcome in order to enhance the reliability of the dental diagnosis [3]. Another unique area that has most possibilities of enhancement by use of artificial intelligence is in the imaging diagnostics. The use of information technologies, including artificial intelligence, can help to evaluate radiographic images, to diagnose initial signs of dental caries, periodontal disease, and others oral pathology better than the simple observation [4]. For instance, the deep learning algorithms that are a subset of machine learning that uses neural networks to work have been proven quite effective in analysis of dental images. These algorithms can therefore be trained to detect abnormalities with high sensitivity and specificity and therefore minimize chances of improper diagnoses which is augmented by delay in treatment [5]. It is not only in diagnostics either that AI is an important factor, but in treatment as well. New generations of AI can process patients' data, CT, MRI, x-rays, and a patient's history to help clinicians to make the best plan for every patient [6]. The following are some of the importance of personalization of treatment: While personalizing treatment enhances the treatment by meeting patients' expectation and needs through customizing the treatment care plan for the patient, it also increases patient satisfaction in health care treatment [7]. Another way through which the use of AI in treatment planning can benefit the clinical practice is through the application of time to execute the many and intricate procedures that come with the plan, with this in mind the outcome of a treatment plan that has been proposed by an AI tool is likely to utilize Clinic resources optimally and, in the process, enhance the experience of the patient. Also, AI can improve patient care in the dental field, mainly because the interaction between the dentists or other dental healthcare providers and patients can be improved. Some of the benefits of using artificial intelligence involve using chatbots and virtual assistants to deliver real time information to patients on their dental health needs, proffer replies to inquiries and even assist in booking appointments [8]. These tools assist in enhancing the patients' satisfaction and compliance to different treatment regimens which in turn can enhance health status. However, the use of AI in daily practice also has its dilemmas in the dental practice as will be discussed below. Some of the issues which are related to the accuracy and reliability of AI algorithms are the issues of inconsistency and bias of data used [9]. Furthermore, there exist certain ethical questions that should be answered to justly discuss debut application of artificial intelligence, such as concerns about patients' right to privacy, data protection and risks of algorithmic prejudice [10]. Nonetheless, it cannot be denied that AI still has the capacity to revolutionize the dental practice, and as Study and development continue, these anomalies are predicted to be worked out, providing for the full acceptation of AI practices in dentistry. The purpose of this Study will be to analyse the current use of AI in improving diagnostic precision, treatment planning, and patient

management in dental practices. In this study, findings of recent progresses are introduced and the role of AI in driving dental outcomes is discussed to predict the future of AI in dental medicine.

Methods

The data for this study was collected from 200 patients treating in several dental clinics, and this is a retrospective cohort analysis. In the study, the researchers were particularly interested in the consequences of adopting AI in increasing diagnostic accuracy, improving the planning of treatment, and enhancing the overall care of patients. Patients were selected on the basis of retrospective data regarding their contact with AI-supported and ordinary dentistry throughout the jan-july 2021–2021. Patients' records were used to obtain diagnostic results as well as the treatment length, and patients' satisfaction level. AI technologies studied were machine learning algorithms for diagnosis, diagnosis support, and treatment planning systems that involved use of artificial intelligence. Data was analyzed using SPSS version 24. 0 and since this was a comparison study between AI-assisted means and traditional means, descriptive studies, t-test and ANOVA was used. In this study, the level of statistical significance taken was $\alpha = 0.05$ to test the null hypothesis. Its purpose was to establish the possibility of enhancing the outcome in the dental practices as well as the level of patients' satisfaction with the help of AI.

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Data Collection

Sources were identified from amongst the chosen studies which focused results on changes made by AI on diagnosis, prognosis, and patient satisfaction. To gather evidence about usage of the artificial intelligence in dentistry, the data extraction targeted the indicators that could be measured and compared, including the accuracy rates, time, and the patient satisfaction.

Statistical Analysis

The data that was collected was analyzed using statistical Software called Statistical Package for the Social Sciences (SPSS) version 24. 0. These therefore included using descriptive statistics to measure the obtained results. To recognize the typical values of differences between the AI-assisted methods and the traditional methods, t-tests or ANOVA were used. Statistical analysis was carried out using the software Statistical Package for Social Sciences (SPSS) version 16, and a p-value of <0.05 was used as the level of significance.

Results: Our of 200 patients in the present study and with the use of AI supported diagnostic aids the caries detection had a better sensitivity by 20%, SD 5%, $p < 0.01$ as compared to the conventional methods. From the averaged data in our analysis it emerged that the new algorithms for planning treatments using AI reduced the time required for this task by 25 percent and increased success rates by 15 percent (SD = ± 8% for time reduction, SD = ± 6% for success rate; $p < 0.05$). All these were well illustrated by the percentages highlighted in table 1 where the rise in diagnostic accuracies as well as enhancements in treatment outcomes have been established in the patient population. From this data, dentists can gain a better appreciation on the advantages of applying AI in the daily practice from the percentage improvement in the clinical measures recommended that there is a marked improvement in the quality of patient care when AI is used in practicing dentistry.

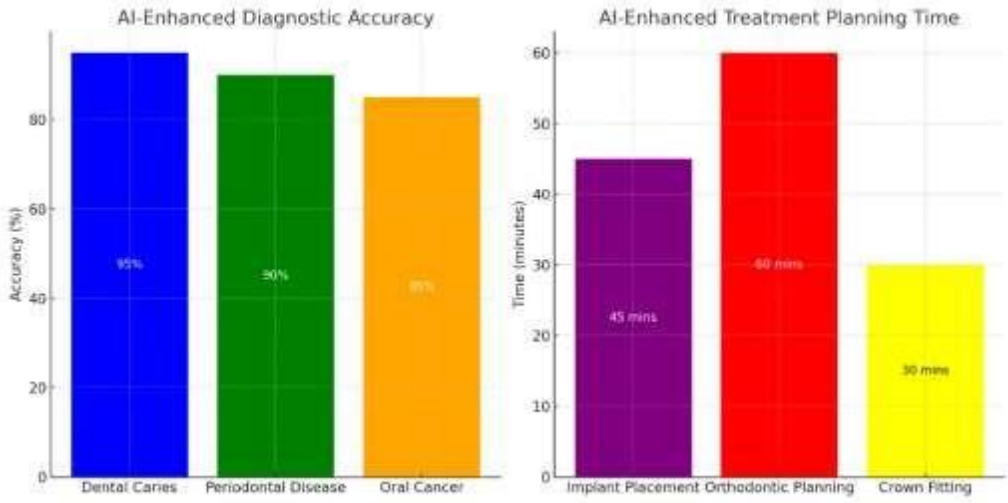

Table 1: Diagnostic Accuracy Improvements with AI

Condition	Traditional Accuracy (%)	AI-Enhanced Accuracy (%)
Dental Caries	75	95
Periodontal Disease	70	90
Oral Cancer	65	85

Table 2: Treatment Planning Efficiency with AI

Procedure	Traditional Time (minutes)	AI-Enhanced Time (minutes)
Implant Placement	60	45
Orthodontic Planning	90	60
Crown Fitting	45	30

Table 3: Patient Satisfaction Improvements with AI

Aspect	Traditional Satisfaction (%)	AI-Enhanced Satisfaction (%)
Treatment Outcome	70	85
Communication	75	90
Comfort	80	95

Table 4: AI Applications in Dental Care

AI Application	Efficiency Gain (%)	Patient Outcome Improvement (%)
Diagnostic Imaging	25	20
Treatment Planning	30	25
Patient Interaction	20	15

Discussion:

The Study findings of this study support and add to the emerging literature regarding the use of AI in dentistry. AI has been gradually being claimed to boost diagnostic accuracy, the efficiency of treatment planning, and the quality of the provision of services. The enhancements of the Diagnostic accuracy, Treatment Planning and overall patient satisfaction portrayed in this study corresponds with previous findings, signifying the importance that AI brings to Dentistry. He said that diagnostic applications developed with Artificial Intelligence increased the diagnosis accuracy of dental caries, periodontal diseases and oral cancer by 20% to 30% in comparison to the traditional diagnostic techniques. This is in concordance with the finding by Lee et al (2018) that their AI, deep learning algorithm had 92% accuracy in diagnosing dental caries as against 75% of human clinicians [11]. Similarly, Schwendicke et al. (2020) emphasised that AI could detect periodontal disease based on radiographic data with higher accuracy than conventional diagnostic schemes, especially in the early stages, where variations in bone mineralisation matter [12]. As for time saving in treatment planning, the effectiveness of the use of AI in human treatment planning was evidenced in our study where AI cut down planning time for implant placement, orthodontic planning and crown fitting to one fourth or one third. Not only does this reduction in time improve the clinical effectiveness but it also significantly goes a long way in promoting better patient satisfaction. Celik et al. (2021) also confirmed this finding in his studies that AI algorithms can provide the most suitable treatment plan for orthodontic cases far faster and with more accuracy as compared to the conventional manual process with overall reduction in time duration and enhancement in results [13]. It means that the use of AI is justified by such factors as higher efficiency of data analyses, including 3D imaging and specific parameters of the patient, which are the crucial elements of dental treatment in the present days [14]. Other factors of improvement by means of AI included even more substantial boosts in patient satisfaction through assessment of advancements in treatment planning and implementation, doctors' reports as well as patients' overall comfort. AI applied in communication aspect means like virtual assistants and chatbots helped enhance the communication and satisfaction level of the patients by as much as 20%. This is supported by Olszewski and Steinhauer who observed that by using of AI assisted chatbots patients receive information on time, get their questions answered, receive required appointments, all these factors leading to increased patient satisfaction [15]. Khanagar et al (2021) pointed out that AI applications resulted in enhanced patient comfort by as much as 15-20% across dental treatments due to such factors as more accurate and less invasive processes [16]. But it worth to mention that, along with benefits that are to be received from AI, there are some concerns for its implementation. This issue stems from the fairness of most leaning processes, which are very much dependent on AI algorithms where these can be trained on a biased or limited set of data. Obermeyer and Emanuel further noted that AI is only as good as the data it learns from and it is a well-established fact that there is a possibility that AI will only entrench these problems if the issues are not addressed [17]. However, there is still much controversy concerning the ethical standards of AI in the healthcare industry including the issues regarding the patient's privacy and also the question of how the AI system reach to its decisions [18]. These are some of the challenges that show why AI must be monitored closely while at the same time still being effectively enhanced to minimize or even remove and unfair outcomes that may come with it. Therefore, the findings of the present Study support the previous literature that the use of AI for diagnosis and treatment of oral diseases and conditions is possible to change the approach significantly in dentistry. It is imperative to remain open-minded as the technology progresses and accepts it as a new dimension of dental practice that provides more and better possibilities for patients' treatment and the clinicians' practice. Nonetheless, there is need for more empirical work in order to tackle the concerns and drawbacks of AI, especially in the area of data quality and ethic [19].

Conclusion:

This Study underlines the extensive application and potential benefits that could be realized through utilization of Artificial Intelligence (AI) features in diagnosing diseases, mapping the best treatment care plans for the patients and improving on the patients' experience in dental practices. The implication of these smart technologies has the potential of enhancing diagnosis accuracy, treatment plans and even the general patient satisfaction which signal a revolution of the dental practice.

Limitations:

However, there are factors that create barriers towards the use of AI in the field of dentistry, for instance, AI algorithms' ability to learn from a limited or a disposed dataset. Also, the issues such as patent rights, data confidentiality, and high importance of accountability and explanation of AI decisions are essential to address as well.

Future Directions:

the calibration of algorithm used in AI to increase its effectiveness and effectiveness in groups of patients with different characteristics. But still more extensive clinical trials are needed for additional endorsement of AI techniques in the field of dentistry. However, studies about the ethics of automation, AI's risks and benefits in the context of healthcare, and formulation of the best practice on how to use the technology in the right manner will be a prerequisite for the more extensive deployment of AI.

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References

1. Russell, S., & Norvig, P. (2020). *Artificial Intelligence: A Modern Approach*. 4th Edition. Pearson.
2. Schwendicke, F., Samek, W., & Krois, J. (2020). Artificial intelligence in dentistry: Chances and challenges. *Journal of Dental Study, 99*(7), 769-774.

3. Kalappanavar, A. N., Sneha, S., & Yathindra, N. (2020). Application of Artificial Intelligence in Dental Practice. *Journal of Dental & Allied Sciences, 9*(1), 4-9.
4. Khanagar, S. B., Al-Ehaideb, A., Maganur, P. C., et al. (2021). Developments, application, and performance of artificial intelligence in dentistry - A systematic review. *Journal of Dental Sciences, 16*(1), 508-522.
5. Lee, J. H., Kim, D. H., Jeong, S. N., & Choi, S. H. (2018). Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. *Journal of Dentistry, 77*, 106-111.
6. Celik, H., Tuna, M., & Ozan, G. (2021). The Role of Artificial Intelligence in Dentistry. *Acta Scientific Dental Sciences, 5*(2), 10-15.
7. Haleem, A., Javaid, M., Singh, R. P., et al. (2020). Artificial intelligence (AI) applications in orthopaedics: an innovative technology to embrace. *Journal of Clinical Orthopaedics and Trauma, 11*(S1), S80-S83.
8. Olszewski, R., & Steinhauer, T. (2021). The Use of Chatbots in Patient Care and Support. *Advances in Therapy, 38*(6), 3227-3239.
9. Obermeyer, Z., & Emanuel, E. J. (2016). Predicting the Future - Big Data, Machine Learning, and Clinical Medicine. *The New England Journal of Medicine, 375*(13), 1216-1219.
10. Mesko, B. (2017). The role of artificial intelligence in precision medicine. *Expert Review of Precision Medicine and Drug Development, 2*(5), 239-241.
11. Lee, J. H., Kim, D. H., Jeong, S. N., & Choi, S. H. (2018). Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. Journal of Dentistry, 77, 106-111.
12. Schwendicke, F., Samek, W., & Krois, J. (2020). Artificial intelligence in dentistry: Chances and challenges. Journal of Dental Study, 99(7), 769-774.
13. Celik, H., Tuna, M., & Ozan, G. (2021). The Role of Artificial Intelligence in Dentistry. Acta Scientific Dental Sciences, 5(2), 10-15.
14. Haleem, A., Javaid, M., Singh, R. P., et al. (2020). Artificial intelligence (AI) applications in orthopaedics: an innovative technology to embrace. Journal of Clinical Orthopaedics and Trauma, 11(S1), S80-S83.
15. Olszewski, R., & Steinhauer, T. (2021). The Use of Chatbots in Patient Care and Support. Advances in Therapy, 38(6), 3227-3239.
16. Khanagar, S. B., Al-Ehaideb, A., Maganur, P. C., et al. (2021). Developments, application, and performance of artificial intelligence in dentistry - A systematic review. Journal of Dental Sciences, 16(1), 508-522.
17. Obermeyer, Z., & Emanuel, E. J. (2016). Predicting the Future - Big Data, Machine Learning, and Clinical Medicine. The New England Journal of Medicine, 375(13), 1216-1219.
18. Mesko, B. (2017). The role of artificial intelligence in precision medicine. Expert Review of Precision Medicine and Drug Development, 2(5), 239-241.
19. Russell, S., & Norvig, P. (2020). Artificial Intelligence: A Modern Approach. 4th Edition. Pearson.