Dental Research Journal

Letter to Editor

Prospects of artificial intelligence in dentistry

Artificial intelligence (AI) algorithms have many purposes in dentistry, including:

1. Disease diagnosis and risk prediction
2. Radiological imaging analysis
3. Personal treatment advice
4. Drug discovery and development
5. Analysis of electronic health records
6. Clinical decision support systems
7. Prognosis and outcome prediction
8. Remote monitoring and teledentistry.

AI algorithms can analyze patient data, dental images, and medical history to assist dentists in diagnosing conditions and planning treatments. This can help in identifying issues such as dental caries, periodontal disease, and dental anomalies and in creating personalized treatment plans for patients.[1]

AI models offer various opportunities for applications in dentistry, including:

1. Image recognition algorithms: These algorithms can analyze dental images such as radiographs, computed tomography (CT) scans, and intraoral images to assist in the detection and analysis of dental conditions, as well as in the segmentation and measurement of dental structures. These algorithms use machine learning and deep learning techniques to analyze and interpret visual data, allowing the computer to recognize objects, patterns, and features within an image[2]
2. Natural language processing: Natural language processing (NLP) algorithms can be used to analyze and interpret electronic health records, patient notes, and other textual data related to dental care. It also offers symptom classification, chat systems for patients, or professional support in clinical documentation[3]
3. Machine learning algorithms: These algorithms may be used to develop personalized treatment plans, predict treatment outcomes, image analysis and interpretation, risk assessment and predictive analysis, provide evidence-based treatment recommendations, and improve clinical decision-making in dentistry[4]
4. Robotics and automation: AI algorithms can be applied to control robotic devices for tasks such as dental surgery, tooth restoration, and other dental procedures. Robotic systems adaptable to complex anatomical variations and advanced AI algorithms are capable of multimodal patient data analysis for more precise treatment planning[5]
5. Virtual assistants and chatbots: AI algorithms can be used to create virtual assistants and chatbots that can provide information, answer patient queries, and schedule appointments in dental practices. It was shown that the medical information in the field of orthognathic surgery provided through chatbots is high quality[6]
6. Predictive analytics: AI algorithms can analyze large datasets to identify patterns and trends, which can help in predicting the likelihood of certain dental conditions or treatment outcomes. This can aid in preventive care and early intervention
7. Personalized treatment planning: AI algorithms can analyze patient data to develop personalized treatment plans, recommend medications, and suggest lifestyle changes for better oral health.

In clinical practice, AI is applied in three main categories: diagnosis, treatment planning, and follow-up. Each category can benefit from several algorithms, as briefly mentioned below.

DIAGNOSIS

Among all the AI applications in dentistry, diagnosis is probably the most popular application.[2]

The convolutional neural network (CNN) is a deep learning algorithm well-suited for image recognition and detection.[2,3] In dentistry, various CNN models have been applied for several purposes. These models include a pretrained GoogLeNet Inception v3 CNN network[7] and multi-input deep CNN ensemble using score[8] for detecting dental caries; a pretrained deep CNN[8] and faster R-CNN model with a pretrained ResNet architecture[9,10] for identifying periodontally compromised teeth; and CNN using combined seagull

optimization algorithm[11] and faster R-CNN with DenseNet121[12] for detecting oral cancer.

A Bayesian-based decision support system can diagnose the need for orthodontic treatment based on orthodontics-related data input.[13] Bayesian algorithm is a classification technique supported by Bayes' theorem with an associate degree assumption of independence among predictors. In easy terms, a Naïve Bayes classifier assumes that the presence of a specific feature in a class is unrelated to the presence of the other features. Bayesian algorithms have several uses in dental diagnosis, particularly where uncertainty and probability are significant factors. For example, they can assist dentists make diagnostic decisions by integrating patient information, symptoms, medical history, and examination findings with prior knowledge or expert opinions. By combining these inputs, the algorithm provides a probability or likelihood of various diagnoses, aiding in the decision-making process. It can also assess the likelihood or risk of developing certain dental conditions based on patient-specific factors, such as age, gender, lifestyle, genetics, and existing oral health conditions. It can be employed in analyzing dental images, such as X-rays or intraoral scans. They aid in detecting abnormalities, dental caries, periodontal diseases, or other pathological conditions by considering the probabilities of specific features or patterns associated with these conditions.

Artificial neural network (ANN) and support vector machine (SVM) models can diagnose malignant and dysplastic oral lesions.[14] SVM is one of the most popular supervised learning algorithms, which is used for classification as well as regression problems. It is primarily used for classification problems in machine learning. The SVM algorithm aims to create an optimal line or decision boundary to separate n-dimensional space into classes, allowing for easy categorization of new data points in the future. It has been used with high accuracy in detecting and categorizing dental abnormalities in cephalometry,[15] osteoporosis in panoramic,[16] healthy bones in cone beam CT (CBCT),[17] oral cancer in histopathological images,[18] and determining tooth color with an intraoral camera.[19]

TREATMENT PLANNING

Some studies have focused on utilizing the AI algorithm for dental treatment planning, particularly in the placement of dental implants, orthodontic treatment, and prosthodontics. The research in this area is advancing rapidly.

In the context of dental implant placement, CNNs are employed to analyze CBCT images and assist in treatment planning by segmenting dental images to differentiate various structures comprising teeth, bone, and soft tissue. This is advantageous for the planning of dental implant placement.[20]

In orthodontic treatment, an ANN model is used to determine the necessity of extractions by analyzing lateral cephalometric radiographs.[13,21] ANN, a machine-learning model, inspired by the neural structure of the human brain, consists of interconnected nodes organized into layers.

Efforts have been made to develop methods for creating dental crowns that replicate the designs of technicians in prosthodontics.[22,23] Currently, there is no AI algorithm available for designing removable dentures; however, current algorithms focus on assisting the design process of removable dentures.

FOLLOW-UP

Several AI algorithms can be applied in dental follow-up visits. Image recognition algorithms can analyze dental images comprising radiographs or intraoral images to assist in the diagnosis and detection of tooth decay or periodontal disease. NLP algorithms can analyze text data from patients' records, medical literature, or online sources to provide insights and recommendations for dental follow-up visits. They assist in generating summaries of patient histories, identifying treatment options, or suggesting posttreatment care instructions. Machine learning algorithms could be trained on large datasets of dental patient information to predict outcomes or patterns. For example, AI algorithms can be utilized to predict the success rate of specific treatments or to identify high-risk patients who may require closer follow-up or preventive measures. Expert systems use knowledge-based rules and reasoning to support decision-making during follow-up visits. They can assist dentists in making diagnoses or treatment plans based on patient symptoms, medical history, and clinical guidelines. It is worth noting that the specific algorithms used in dental follow-up visits can vary based on the type of data available, the desired outcome, and the specific application.

Other applications of AI in dentistry include the following:

1. Patient management and scheduling: AI algorithms might assist in managing patient appointments, scheduling, and reminders, helping to optimize clinic efficiency and patient satisfaction
2. Patient communication and education: AI-powered chatbots or virtual assistants can provide patients with information about dental procedures, treatment options, and posttreatment care, improving patient education and engagement.

It may not be clear how the algorithm reached its conclusions, making it difficult to replicate and verify the results. AI algorithms might be sensitive to biases in the training data or performance of the algorithms, such as local optima in machine learning. Thus, human supervision and expertise must be involved to verify results, interpret findings, and ensure overall quality. AI should not be seen as a replacement for human judgment but as a tool to increase efficiency and effectiveness.[24]

There is a consideration that the ethical concerns regarding the use of AI in dentistry are unnoticed in the current landscape. It is crucial for the dental research communities, journal editors, and clinical practitioners to proactively prioritize and address this significant and emerging issue.[25]

In conclusion, the use of AI algorithms in dentistry has the potential to improve the accuracy, efficiency, and personalized care in dental practice, as well as the enhancing precision of dental diagnosis and treatment planning leading to better patient outcomes and experiences. Given the numerous applications of AI in dentistry, it is essential for dentists to focus on this area to fully benefit from its applications [Figure 1].

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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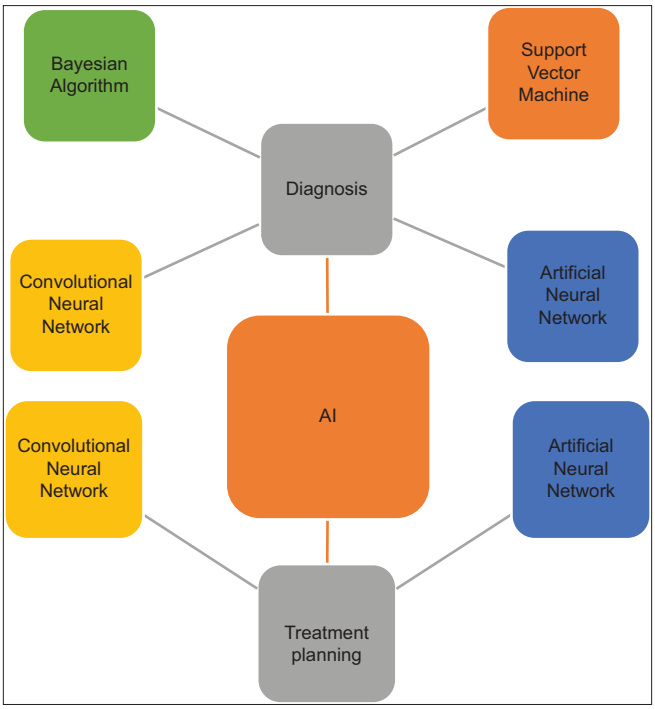

Figure 1: Artificial intelligence algorithms in dentistry.

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