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Artificial Intelligence in Pediatric Dentistry: A Review

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ABSTRACT

AI (a term coined by John McCarthy in 1955) refers to the ability of machines to acquire and apply knowledge to perform a variety of cognitive tasks (e.g., sensing, processing oral language, reasoning, learning and making decisions), basically mimicking human behaviour. ML (a term coined by Arthur Samuel, in 1959) is a subset of AI that allows systems to automatically learn and improve from experience without being explicitly programmed. ML develops computer programmes that can access data and use it to learn for themselves. AI components in imaging machines would reduce this workload and drive greater efficiency. There are various applications of artificial intelligence in paediatric dentistry. This paper reviews the various applications of AI in paediatric dentistry.

Keywords: Artificial Intelligence; Machine Learning; Deep Learning ; Paediatric Dentistry

INTRODUCTION

Artificial intelligence (AI) is widely defined as a tool which encompasses any techniques that enable computers to mimic human behaviour and excel over human decision-making to solve complex tasks independently or with minimal human intervention. John McCarthy is called the father of artificial intelligence these machines can solve problems based on the data input. Machine Learning or ML (a term coined by Arthur Samuel, 1959) is a subset of AI that allows systems to automatically learn and improve from experience without being explicitly programmed. ML develops computer programmes that can access data and use it to learn for themselves. Machine learning (ML) is a subset of artificial ML that predicts the outcome based on the dataset provided to it using algorithms, such as artificial neural networks (ANN).[1] Examples of AI are Self Driving Cars, Chatbot, Face Recognition, and Recommendation Systems. AI is a recent technological advance that has swiftly acquired traction in the field of science and technology. AI heavily relies upon imaging, which thrives as a cornerstone for dentistry to a large extent. AI is highly beneficial in continuously assessing and monitoring a patient's health, understanding the long-term effects of a drug, and knowing any health-related risk beforehand. Its application in healthcare includes covid-19 diagnosis, glucose monitoring, cancer prediction etc. AI has the potential to completely eliminate the long hours invested by dental professionals.[2] Additionally, it is feasible to improve people's health at lower costs, provide customized, preventative, and predictive dentistry, and integrate healthcare for everyone. Above all, AI has the potential to increase the standards of dental care, fine-tune the accuracy and effectiveness of diagnosis, come up with better visuals for treatment, simulated results, and predict oral diseases and health. AI has several potential uses in paediatric dentistry, which could change the face of behavioural paediatric practice in the future on panoramic radiographs, the AI system proved successful in recognising and counting the primary teeth of children.AI is also useful in forensic identification, in addition to providing as a time-saving tool and a clinician's aid.[3]

APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN PEDIATRIC DENTISTRY

A. IN RESTORATIVE PEDIATRIC DENTISTRY

AI-enabled restorative dentistry with computer-aided design and computer-aided manufacturing technology is well-established, and it would be a time and aesthetic benefit for paediatric restorations. Deep Learning is another subset of Machine learning that is a complex multilayer system that permits the visualization of simple features such as lines, edges, corners and macroscopic patterns in a hierarchical structure, which can find practical use in conservative caries excavation and tooth preparation for accommodating restorations.[4]

B. DENTAL PLAQUE

You, W. et al. have developed AI model-based deep learning techniques to identify plaque-affected primary teeth, it is still under research (CNN framework) that were trained on 886 tooth photos to point out plaque accumulation. The model was compared with a trained paediatric dentist and achieved clinically acceptable performance levels.[6]

C. ENDODONTIC AND ORTHODONTIC PROCEDURES

Data acquired from diagnostic imaging such as periapical radiographs, computed tomography scans and magnetic resonance imaging scans can be good sources of input for AR information. This allows the dentist to obtain critical information such as the intricate anatomy of root canals while maintaining focus on the operating field in contrast to the conventional systems. Such real-time information presented three-dimensionally on the patient's body is more efficient and avoids confusion in comparison to being presented on a separate screen. Early orthodontic tooth movement is also gaining traction, with personalized AI-driven appliances that are more acceptable to the younger generation.[5]

D. IN LOCAL ANESTHESIA

The new, better path to injection-free paediatric dentistry practice is pain control with AI-Enabled devices. In children, anaesthetic nanorobots if introduced in a suspension into the quadrant of interest, will reach the pulp via the gingival sulcus, lamina propria and the dentinal tubules and block the action potentials in the sensory nerves upon activation by the dentist until such time as decided by the dentist when he/she can command the robots to deactivate.[6]

E. PREDICTION MODELS

GA and Artificial Neural Networks (ANN) have found use in the prediction and interpretation of biological activities such as dental caries. If a proper training database representing values for a particular population is established, GA and ANN can be used to predict the sizes of unerupted teeth. An artificial neural network-derived model was used in a study to predict toothache on the basis of its association with toothbrushing time, daily tooth-brushing frequency, toothbrush replacement to the pattern, use of dental floss, undergoing scaling and other epigenetic factors such as diet and exercise. The result was a toothache predictive model of great accuracy which recognized oral hygiene, adequate eating habits and prevention of stress as the essential factors in preventing toothaches.[4]

F. DIAGNOSIS, TREATMENT PLANNING AND DATA MANAGEMENT

AI makes room for a more systematic and organized collection of patient data, reduces routine tasks, facilitates research and development and is a promising alternative for a more participatory healthcare system. AI is more focused on fabricating a well-built system for each process by extracting appropriate data from a sizeable amount of medical records to assist dental professionals in making decisions along with helping patients to understand the disease and its prognosis[5]

G. ASSESSING CHILDREN'S ORAL HEALTH

Wang, Y. et al. developed a tool kit which consisted of a short form (SF) to assist parents in evaluating their children's oral health status and need for treatment, which conceptualized health as having physical, mental, and social components. The toolkit's (SF) accuracy greatly depended on the way questions were framed, the knowledge quotient of kids and their parents, the time of day when the survey was done, and, above all, how the machine learning algorithm was developed. The main idea of this toolkit was to additionally help the dentist with dental examinations, but never as a total replacement for the physical oral check. [10]

H. SUPERNUMERARY TOOTH IDENTIFICATION

Ahn, Y. et al. used a deep learning model to detect mesiodens in primary or mixed dentition, implying that this method could help clinicians with limited clinical experience accomplish more accurate and timely diagnoses. A study by Mine, Y. et al. made use of three CNN models (AlexNet, VGG16-TL, and InceptionV3-TL) to single out the presence of supernumerary teeth in the early mixed dentition stage, and surprisingly, all three models performed well. deep-learning algorithms (DetecNet and AlexNet) have the potential to detect maxillary impacted supernumerary teeth on panoramic radiographs[8]

I. DETECTING DECIDUOUS AND YOUNG PERMANENT TOOTH

Kilic, M.C. et al. investigated a faster R-CNN inception v2 approach for recognizing and numbering primary teeth on paediatric panoramic radiographs, and they reported good sensitivity and accuracy scores. They noticed from their study that only primary teeth were detected and numbered, which also plays a valuable role in forensic identification. Kaya, E. et al. tested the effectiveness of a deep learning system for automated tooth recognition and counting using YOLOv4, a CNN-based object identification model. The model was able to recognize and count both primary and permanent teeth.[12]

J. CHRONOLOGICAL AGE ASSESSMENT IN KIDS

Zaborowicz, K. et al. focused on producing a new method for detecting the chronological age of kids and adolescents aged 4–15 years using digital pantographic images and neural modelling. This method is simpler, has a near-perfect accuracy, and was one of the first to use pantographic images for metric age assessment; however, one of its major limitations is that it does not use 2D photographs and only works with pantographic images.[11]

CONCLUSION

The use of artificial intelligence (AI) and machine learning systems is escalating in all frontiers including pediatric dentistry. AI could help overcome the flaws in traditional dental care that have been widely criticized. AI in dentistry is emerging as a benefit to clinicians in improving patients and simplifying complicated protocols by providing predictable outcomes. Major disadvantages are that AI's mechanism is quite complicated and the Costs of setup are high. Artificial Intelligence in paediatric dentistry is currently in the early stage, and it is rapidly evolving day by day. Hence extensive research is going on in this field. However, how much ever technology improves artificial intelligence cannot take human's place.

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