



Artificial Intelligence – A Spoke of luck to pediatric dentistry

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ABSTRACT:

Background: Artificial Intelligence (AI) has prevailed in recent years over a wide range of sectors of dentistry. It helps in making complex predictions and decisions with improved patient care within time constraints. Use of AI in life, gives excitement to child patients. Normal human intelligence can be replicated by AI machine which helps accurate decision making and avoiding human errors. The evolution of AI such as in convolution neural network, artificial neural network and deep learning have shown greater application in the field of pediatric endodontics, which includes studying the anatomy of tooth and canal. According to the literature AI is mainly used for early and precise diagnosis that aid in helping the clinician for developing proper effective and accurate preventive mode of treatment plan. AI has shown its various applications in the field of pediatric dentistry.

Aim: Promising applications of AI can bring a change in pediatric practice in the coming years. Thus, the aim of this research was to enlighten on the multitudinous possibilities of using AI in pediatric dentistry.

Methods: A literature search was conducted using the keywords “artificial intelligence” and “dentistry” published since 2020 in English and Italian in the following databases: PubMed, CINAHL, Med Line. Excluding items which did not meet the inclusion criteria, 35 articles were included in the review.

Conclusion: Artificial intelligence has great scope in the field of pediatric dentistry and dentistry as a whole, in the areas of diagnosis, treatment planning, patient follow up and research. AI can provide dentists with more accurate diagnosis and treatment planning, while improving patient care and outcomes. As the use of artificial intelligence in dentistry progresses, more innovations and developments are expected in this field.

1. Introduction

The concept of “Artificial Intelligence” (AI) was conceived in the year 1943, but the term was given by John McCarthy in a conference in the year of 1956, and the concept revolved around manufacturing machines that could replicate the tasks done by mankind.[1,2]

John McCarthy defined artificial intelligence (AI) in 1956, as " a field of science and engineering involved with the machine understanding of what's usually known as intelligent behaviour, and with the creation of artefacts that manifest such behaviour" In other words, AI is a technology that helps machines to perform tasks or evaluate results that are usually performed by humans.[3]

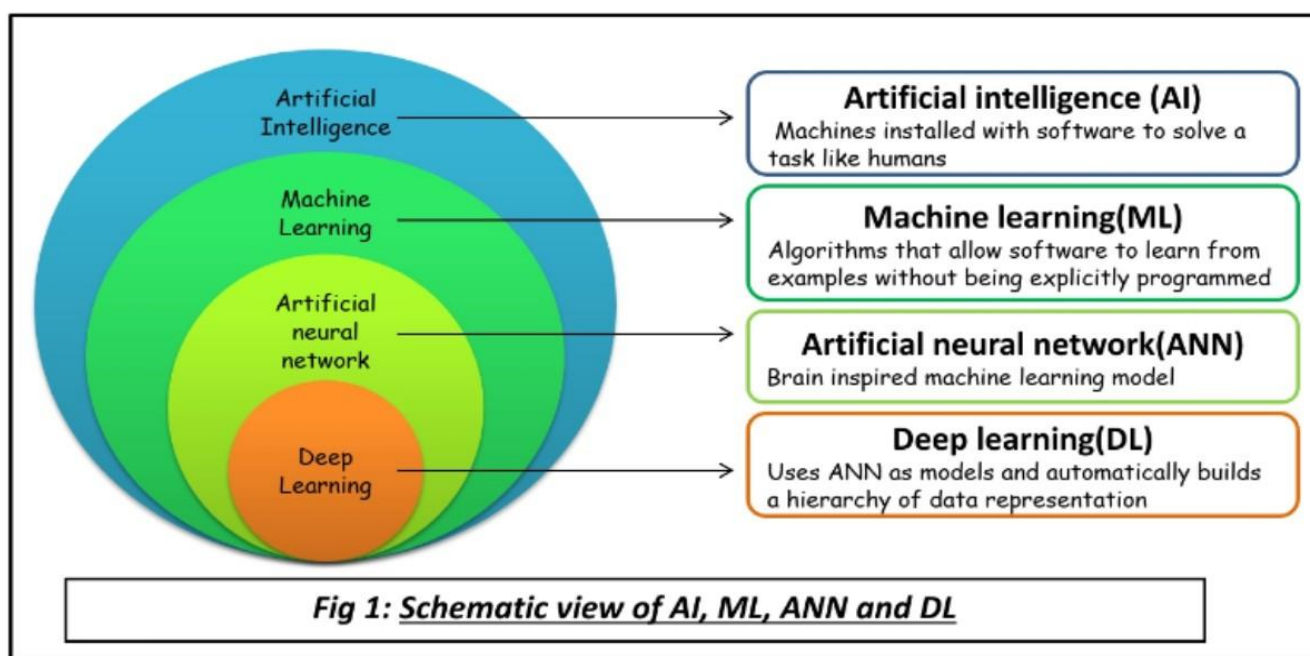


Various forms of AI in dentistry have been introduced in the last twenty years. Machine learning (ML) was one of the prevalent type of AI it was with the help of ML the application of AI in dentistry was initiated. In ML, the main goal was to design a system using algorithms so as it can learn and operate without explicitly planning and dictating each action.[4,5] Nowadays, machine learning (ML) and deep learning (DL) are the two major branches of AI that are used in dentistry, instead of the written guidelines used in the past. They are more accurate and precise as they are trained using large amounts of data and algorithms. One group of DL is Artificial Neural Network (ANN), which comprises smaller communicating units known as neurons that are arranged in layers. [5]A subclass of ANN, convolutional neural networks (CNN), is commonly used in dentistry. Identification of anatomical structures, detection dental caries can be done using CNN they can also replace cone-beam computer tomography (CBCT) in pediatric dentistry

to increase with increase use of AI with better visuals for diagnosis, treatment planning and predict oral diseases.[6-8]AI models act as a primary tools by increasing the precision with probable diagnosis or findings. [9,10]

Artificial intelligence can play major role in patient follow-up and evaluation of treatment. With the help of patients electronic data of dental health the general health of patients can be analyzed. By this, dentists can better monitor patients' dental and overall health, hygiene, gingival health and other dental problems and optimize the treatment process and accuracy of diagnosis.[9]

Upper most dental treatment procedures are made highly feasible by implementing AI systems as a supportive aid to dentists. This in turn facilitates prediction of better treatment results as well as precision in diagnosis and treatment planning. While deep learning primarily assists dentists with diagnosis,



(Fig 1).[6]

AI has the great potential to completely eliminate the long hours invested by dental professionals on identifying anatomic structures etc. With added benefit, it is helpful for the betterment of people's health at lower costs by providing customized, preventative, and predictive dentistry, and better healthcare facility for everyone. The standards of dental care has the potential

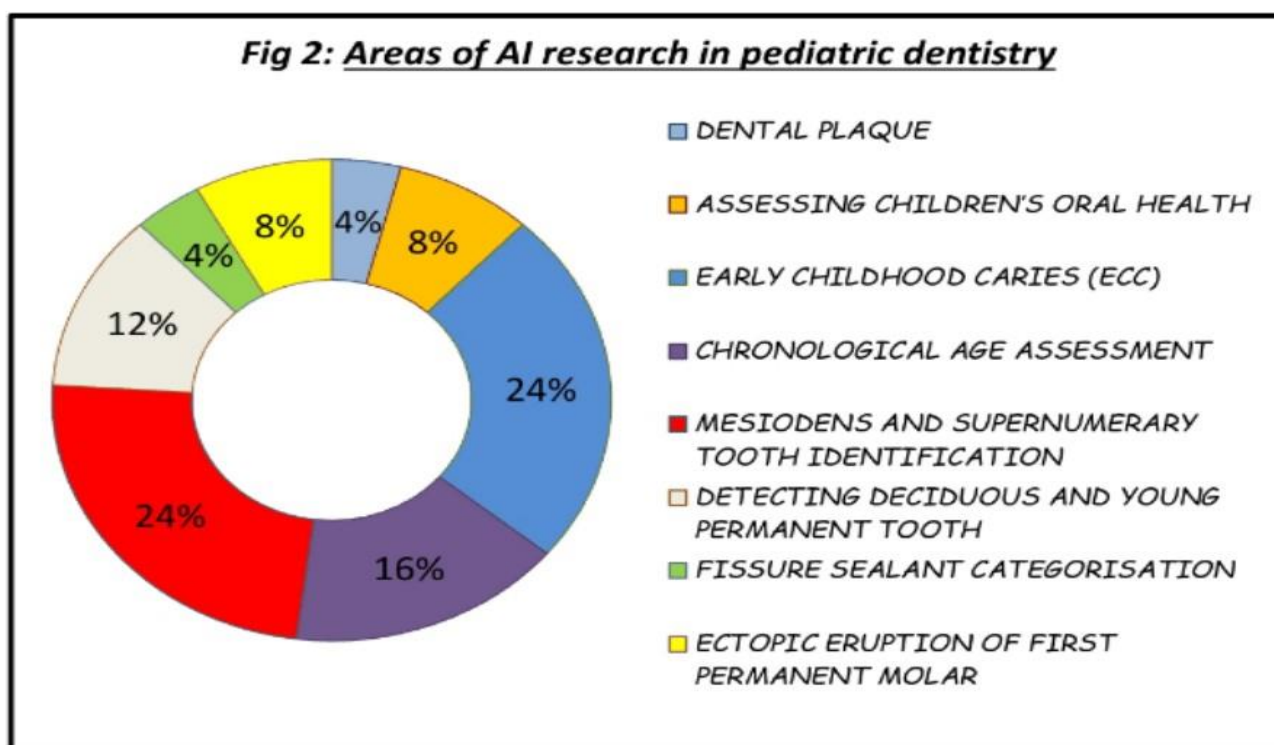
AI claims to increase the productivity of the dentist besides accuracy and precision.[9]

AI system showing its vital role in providing its benefits in various pediatric dental procedures. For a quicker and more accurate diagnosis CNN models have been utilized in pediatric dentistry.[11]



AI models developed for application in pediatric dentistry have mainly focused on: (Fig 2)

- Dental plaque
- ECC
- Fissure sealant categorization
- Supernumerary tooth identification
- Chronological age assessment
- Identification of deciduous and young permanent teeth
- Children's oral health
- Ectopic eruption



DENTAL PLAQUE

With the availability of image analysis software and digital camera total plaque affected area was measured. However now, AI model based deep learning techniques to identify plaque affected primary teeth, a first of its kind study, are under research. [12,13]

ASSESSING CHILDREN'S ORAL HEALTH USING TOOLKITS DESIGNED BY MACHINE LEARNING

Most of the population does not give much importance to oral health compared to other parts of the body, and not even annual oral check up has been taken by majority of population. This holds true especially in underdeveloped and developing countries. The World

Health Organization (WHO) developed an oral health questionnaire [14] for all adults and children to address these concerns. A research team aimed to make use of machine learning to build oral health assessment toolkits that was well equipped to predict the Children Oral Health Status Index (COHSI) and Referral for Treatment Needs (RFTN)[14,15]

The oral health conceptual model was developed by an expert panel of pediatric dentists, general dentists, social scientists, and PROMIS experts. The conceptual model is divided into three main components: physical, mental, and social health. The oral health item bank system created in this paper provides the foundation for other purposes, such as creating specific targeted short forms for program evaluation and/or oral ' health policy planning, and others.[11]



EARLY CHILDHOOD CARIES (ECC)

ECC is a multifactorial problem associated with several other factors.[16,17] The factors responsible seem disoriented from the environmental and behavioural factors, which makes us to think if there is an underlying biological factor, i.e., genetic factor, that has a greater impact on formation of caries.[18] Researchers have come up with different genes and gene polymorphisms responsible for dental lesions in patients, but most studies lack genetic factors associated with the disease. [18,19]

According to Zaorska, K. et al. The use of single nucleotide polymorphisms (SNPs) for anticipating the risk of dental caries could be a highly valuable tool for clinicians to incorporate prevention strategies during the early stages of a child's life and for parents in terms of inculcating improved eating habits.[18]

CHRONOLOGICAL AGE ASSESSMENT IN KIDS AND ADOLESCENTS USING NEURAL MODELLING

For clinicians knowing the metric age assessment might be indispensable based on the analysis of forensic human remains to make the best treatment choices, as well to assess the age of children during adoptions or illegal stays in some countries.[20] Sexual dimorphism results in quicker teeth development in girls compared to boys. Incorporating artificial neural networks to handle medical-related data has gained importance in recent times, and it offers better and more efficient diagnostics in various medical conditions [20-,22]

Estimation of dental age is generally done by using one of two methods, namely the clinical method or the pantomographic method.[20] Zaborowicz, M. et al. [23] assessed chronological age of kids and adolescents aged 4-15yrs and showed that neural modeling algorithms may accurately determine metric age using proprietary teeth and bone indicators. Lee, Y.H. et al. [24] conducted an interesting study that used 18 radiomorphometric parameters extracted from panoramic radiographs (PRs) and focused primarily on developing ML algorithms. They observed that ML algorithms are more efficient at estimating age compared to traditional estimation.

MESIODENS AND SUPERNUMERARY TOOTH IDENTIFICATION

Artificial intelligence finds its use in diagnosing mesiodens by utilizing single deep learning models.[25] Missing the presence of supernumerary teeth on panoramic radio- graphs is largely due to the screening performance of young and inexperienced dental personnel.[26] In fact not many general dentists are versatile in diagnosis of mixed dentition in children. These drawbacks, CNNbased deep learning could provide extensive support in screening supernumerary teeth[27] Ahn, Y. et al. [28] 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. They made use of multiple deep learning models.

When compared to the various types of study done on permanent dentition by Kuwada et al.[29].The YOLO method is a prominent example of a deep learning (DL) detection technique, and it has shown much superior performance when compared to other detection algorithms. The smaller sample size was also a limitation of their study, and it was suggested that a larger sample size from more centres would improve the model's performance. Hence, the CNN-based deep learning method is a promising technology for supporting dentists in their diagnostic work; nonetheless, more improvements are required for clinical applications before it can be used.[11]

DETECTING DECIDUOUS AND YOUNG PERMANENT TOOTH

CNN, one of the most popular architectures of deep learning, is commonly used for object recognition. Deep learning methods such as CNN are increasingly being used for assessing and enumerating deciduous teeth in pediatric patients. Tooth identification serves as the foundation for automated and complex detection systems, which subsequently identify which teeth are affected by dental diseases and assign those disorders to the identified teeth.[30]CNN algorithms were employed by Caliskan, S. et al. [31] to identify and categorize submerged molars, and the researchers found that the approach was effective.



FISSURE SEALANT CATEGORISATION

Dental sealants are widely used as a protective coating on the chewing surfaces of molars to protect them from cavities [32]. Convolutional neural networks (CNNs) are used profoundly to classify diagnostic images and objectify pathological findings' classification, but these networks must be trained exclusively to identify each of the problems. CNN is an integral deep learning algorithm that relies on heaps of data to assist dental practitioners. Additionally, dental sealants are the first go-to solution for many dental problems and can be easily identified as they are generally white in color. Hence, fine-tuning CNN to identify dental sealants seems to be the most logical solution.[33]

However, there were a couple of limitations that needed in-depth dental research, repeated training for accurate detection and categorization of the various diseases and their restoration procedures before using this AI-trained CNN in clinical applications.[11]

ECTOPIC ERUPTION OF FIRST PERMANENT MOLAR

When a tooth erupts in an irregular location, called an "ectopic eruption", it often occurs during early mixed dentition.[11] Hence, an early diagnosis may aid in treatment planning and perhaps avert unwanted problems [34]

Zhu, H. et al. found that the model (nnU-Net) was more consistent and accurate in detecting and segmenting ectopic eruptions in molars in the mixed dentition period. They did a performance analysis on various models, and discovered that nnU-Net had the best results when it came to semantic augmentation.[35]

CONCLUSION

Artificial intelligence has great scope in the field of pediatric dentistry and dentistry as a whole, in the areas of diagnosis, treatment planning, patient follow up and research. AI can provide dentists with more accurate diagnosis and treatment planning, while improving patient care and outcomes. As the use of artificial intelligence in dentistry progresses, more innovations and developments are expected in this field.

Without a doubt, we can say that AI can be of assistance in every area of dental health but can never be a replacement for dental clinicians/pediatric dentists.

Why this review is important to dentists and pediatric dentists?

1. Facilitates early and accurate diagnosis of dental conditions
2. Refine routine dental tasks like appointment scheduling, patient management thus increasing overall efficiency
3. Precise treatment planning and customized intervention

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