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Artificial Intelligence in Pediatric Dentistry: A Narrative Review

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Abstract

Artificial Intelligence (AI) has emerged as a transformative technology in healthcare and dentistry, significantly influencing diagnosis, treatment planning, patient management and clinical decision-making. In pediatric dentistry, AI applications are rapidly expanding due to the increasing availability of digital imaging, machine learning algorithms and advanced computational tools. Technologies such as machine learning, deep learning, convolutional neural networks and natural language processing have demonstrated promising outcomes in early childhood caries detection, dental age estimation, orthodontic assessment, anomaly identification and behaviour management. AI-driven systems also contribute to improved efficiency in teledentistry, radiographic interpretation, image segmentation and personalized treatment planning. Furthermore, virtual reality and augmented reality technologies are being integrated into pediatric dental care to reduce anxiety and improve patient cooperation.

Despite the remarkable advancements, concerns regarding ethical issues, data privacy, algorithmic bias, lack of standardized datasets and limited clinical validation continue to challenge widespread implementation. This review article summarizes the fundamental concepts of AI, explores its major applications in pediatric dentistry and discusses future prospects, limitations and ethical considerations associated with its integration into pediatric oral healthcare.

Keywords: Artificial Intelligence, Pediatric Dentistry, Machine Learning, Deep Learning, Dental Imaging, Caries Detection, Teledentistry

Introduction

Artificial Intelligence (AI) refers to the ability of computer systems to simulate human intelligence and perform tasks such as learning, reasoning, problem-solving and decision-making. Since the term was coined by John McCarthy in 1955, AI has evolved into one of the most rapidly advancing technologies in healthcare. AI systems are capable of learning from large datasets, recognizing patterns and generating predictions with minimal human intervention. [1]

In dentistry, AI has significantly enhanced diagnostic accuracy, treatment planning and patient management. The integration of AI into pediatric dentistry is particularly valuable because children require specialized diagnostic and behavioural approaches that differ from adult dental care. AI-driven technologies provide opportunities for early disease detection, improved radiographic interpretation, personalized treatment planning and enhanced patient communication.[2]

The emergence of machine learning (ML), deep learning (DL), artificial neural networks (ANNs) and convolutional neural networks (CNNs) has accelerated the use of AI in dental imaging and clinical applications. AI can analyse radiographs, detect dental caries, identify anomalies, estimate dental age and assist clinicians in orthodontic planning with high accuracy. In addition, AI-based virtual reality and augmented reality systems are increasingly used for behaviour management and pain reduction among pediatric patients.[1,3,4]

This review aims to summarize the current applications, advantages, limitations and future implications of AI in pediatric dentistry.

History and Evolution of Artificial Intelligence in Dentistry

The concept of AI originated during the Dartmouth Conference in 1956, where John McCarthy introduced the term “Artificial Intelligence.” Early AI systems relied on symbolic reasoning and rule-based programming. During the late 1980s and 1990s, the focus shifted toward neural networks and machine learning, enabling systems to learn from data rather than depending entirely on predefined rules.[5]

The development of deep learning and increased computational power during the 2000s revolutionized healthcare applications of AI. Convolutional neural networks became highly effective in image analysis, making them suitable for dental radiographic interpretation.[1,2]

Dentistry gradually adopted AI technologies for radiographic diagnosis, treatment planning and digital workflows. Recent advancements in pediatric dentistry include automated tooth numbering, caries detection, anomaly identification, orthodontic prediction models and AI-based behavioural management systems. (Figure 1)[6,7]

Fundamentals of Artificial Intelligence

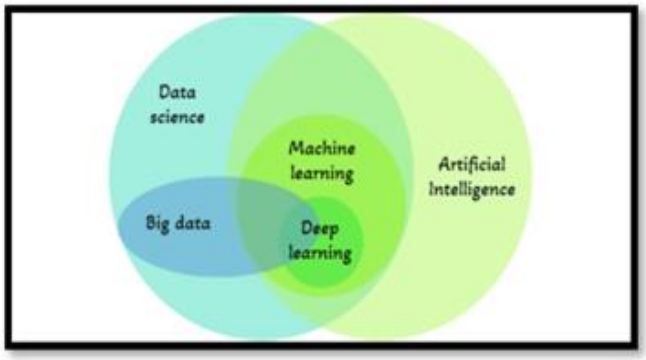


Figure 1: Fundamentals of Artificial Intelligence [4]

Machine Learning

Machine learning is a subset of AI in which algorithms learn patterns from datasets and make predictions or decisions. ML can be classified into supervised learning, unsupervised learning and semi-supervised learning.[5,8]

- **Supervised learning:** Uses labelled datasets for training.
- **Unsupervised learning:** Identifies hidden patterns in unlabelled data.
- **Semi-supervised learning:** Combines both labelled and unlabelled data.

Machine learning algorithms commonly used in dentistry include support vector machines, random forests, logistic regression and naïve Bayes classifiers.

Deep Learning

Deep learning is an advanced subset of machine learning that uses artificial neural networks with multiple hidden layers. Deep learning algorithms are capable of automatically extracting features from complex datasets such as panoramic radiographs and CBCT images.[9]

Convolutional Neural Networks

CNNs are specialized deep learning architectures designed for image analysis. They are widely used in dentistry for caries detection, cephalometric landmark identification, tooth segmentation and radiographic interpretation.[1,2]

Natural Language Processing

Natural language processing enables AI systems to understand and generate human language. NLP-based chatbots and virtual assistants are increasingly used in patient communication, appointment scheduling and oral health education.[1,2]

Computer Vision

Computer vision enables machines to analyse visual information from radiographs, intraoral scans and photographs. This technology supports automated disease detection and diagnostic interpretation.[10]

Hierarchy of Artificial Intelligence System

Artificial intelligence follows a hierarchical structure consisting of machine learning, neural networks and deep learning (dl). Machine learning enables systems to learn from data and improve performance without explicit programming, while neural networks simulate the functioning of the human brain through interconnected neurons. Deep learning, a subset of neural networks, utilizes multiple computational layers for advanced pattern recognition and is widely used in dental image analysis, diagnosis, and treatment planning.(Figure 2)[14]

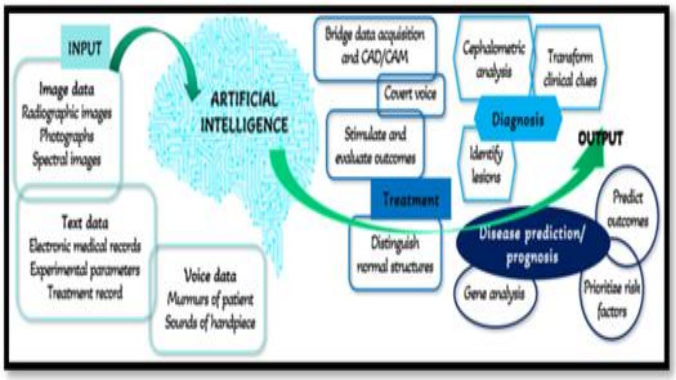


Figure 2: Hierarchy of artificial intelligence system[4]

Applications of AI

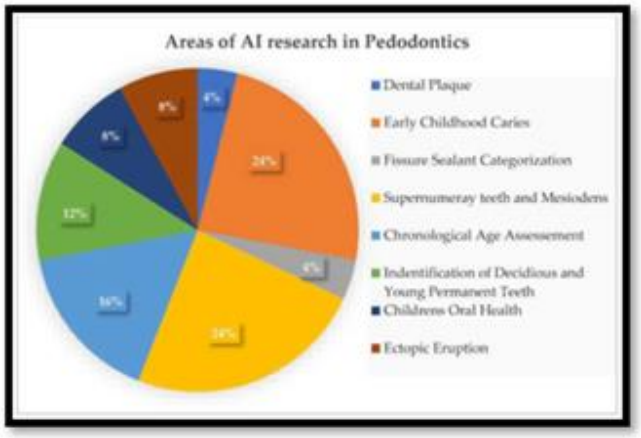


Figure 3: Applications- areas of AI research[15]

- **Caries Detection and Diagnosis**

Dental caries remains one of the most common chronic diseases affecting children. AI systems using deep learning and CNN algorithms have demonstrated high sensitivity and specificity in detecting early childhood caries from bitewing radiographs and clinical photographs.[2,3,7]

AI-assisted diagnostic systems can identify subtle radiographic changes that may not be visible to clinicians during routine examination. Several studies have shown that AI models can achieve diagnostic accuracies exceeding 90% for proximal caries detection.[1,11]

Smartphone-based applications and AI-powered caries assessment tools also enable parents and clinicians to monitor oral health remotely.[1]

- **Dental Age Estimation**

Dental age estimation is important in pediatric dentistry, orthodontics and forensic odontology. Traditional methods such as Demirjian, Willems and Cameriere techniques rely on radiographic assessment of tooth development.[1]

AI-based systems improve age estimation accuracy by analysing panoramic radiographs using neural networks and machine learning models. These systems reduce observer variability and provide rapid and objective assessments.[6,7]

- **Detection of Dental Anomalies**

AI systems are increasingly used for detecting developmental anomalies such as:

- Mesiodens
- Supernumerary teeth
- Taurodontism
- Ectopic eruption
- Congenitally missing teeth
- Cleft-associated dental abnormalities

Deep learning algorithms can analyse panoramic radiographs and CBCT images with high accuracy, assisting clinicians in early diagnosis and treatment planning.[1,4,7]

- **Orthodontic Applications**

AI has significantly transformed orthodontic diagnosis and treatment planning in pediatric patients.

Applications include:

- Cephalometric landmark identification
- Growth prediction
- Malocclusion classification
- Treatment outcome prediction
- Automatic tooth segmentation
- Space analysis and extraction decisions

AI-driven orthodontic systems reduce manual workload and improve precision in diagnosis and treatment planning.[10]

- **Image Segmentation and CBCT Analysis**

AI-assisted image segmentation is widely used in pediatric dental radiology. Deep learning models can automatically identify teeth, bone structures and anatomical landmarks in CBCT images.

Automated segmentation improves diagnostic efficiency and reduces interpretation time. AI systems are also

capable of detecting pathologies, evaluating eruption patterns and supporting surgical planning.[10]

- **Behaviour Management and Pain Reduction**

Behaviour management is a critical component of pediatric dentistry. AI-based technologies such as virtual reality (VR), augmented reality (AR) and humanoid robots are increasingly used to reduce dental anxiety and improve patient cooperation. [4,12]

VR distraction techniques immerse children in interactive virtual environments during dental procedures, reducing fear and discomfort. AI-powered chatbots and virtual assistants can also educate children and parents regarding dental procedures in a child-friendly manner.[7]

- **Teledentistry and Remote Monitoring**

AI has strengthened teledentistry by enabling remote diagnosis, patient monitoring and consultation. AI-powered systems can analyse images submitted through smartphones and provide preliminary assessments.[1]

Remote monitoring systems improve access to dental care in underserved areas and facilitate preventive interventions.[10,12]

- **Clinical Decision Support Systems**

Clinical Decision Support Systems (CDSS) integrate patient information with AI algorithms to assist clinicians in diagnosis and treatment planning.[1]

These systems analyse patient records, radiographs and clinical findings to provide evidence-based recommendations, improving efficiency and reducing human error.[2]

- **AI in Dental Education and Research**

AI technologies are increasingly integrated into dental education through virtual simulations, digital learning platforms and intelligent tutoring systems. Virtual reality simulators allow students to practice procedures in risk-free environments. [13,14]

AI also supports research by enabling automated data analysis, literature review assistance and predictive modelling.[13,14]

Advantages of Artificial Intelligence

The integration of AI in pediatric dentistry offers numerous advantages:

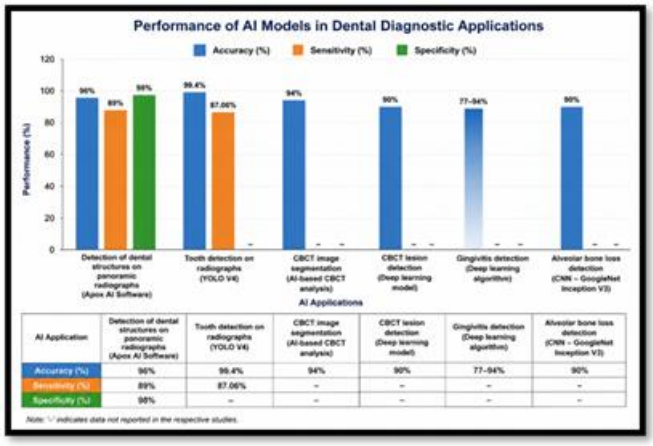
- Improved diagnostic accuracy
- Early disease detection
- Faster image interpretation
- Enhanced treatment planning
- Reduced clinical workload
- Personalized patient care
- Better patient communication
- Improved workflow efficiency
- Enhanced preventive care
- Remote monitoring capabilities

AI systems can assist clinicians in making evidence-based decisions while minimizing diagnostic errors.[2,10,13]

Application	AI Model Used	Accuracy	Sensitivity	Specificity
Detection of dental structures on panoramic radiographs	Apox AI Software	96%	89%	98%
Tooth detection on radiographs	YOLO V4	99.4%	87.06%	—
CBCT image segmentation	AI-based CBCT analysis	94%	—	—
CBCT lesion detection	Deep learning model	90%	—	—
Gingivitis detection	Deep learning algorithm	77–94%	—	—
Alveolar bone loss detection	CNN (GoogleNet Inception V3)	90%	—	—

Diagnostic Accuracy and Performance

Several studies have demonstrated high accuracy, sensitivity, and specificity of AI systems In dental diagnosis: [11]



AI Application	Detection of dental structures on panoramic radiographs (Apex AI Software)	Tooth detection on radiographs (YOLO V4)	CBCT image segmentation (AI-based CBCT analysis)	CBCT lesion detection (Deep learning model)	Gingivitis detection (Deep learning algorithm)	Alveolar bone loss detection (CNN – GoogleNet Inception V3)
Accuracy (%)	96%	99.4%	94%	90%	77–94%	90%
Sensitivity (%)	89%	87.06%	–	–	–	–
Specificity (%)	96%	–	–	–	–	–

Note: '–' indicates data not reported in the respective studies.

Figure 4: Performance of AI model in dental diagnostics applications

Global Market and Technological Growth

- The global Artificial Intelligence market was valued at approximately USD 454.12 billion in 2022 and is projected to reach USD 2575.16 billion by 2032, growing at a compound annual growth rate (CAGR) of 19%**.**
- The AI in dentistry market alone is expected to reach approximately USD 1.3 billion by 2026.
- Around 3.5 billion people worldwide are affected by oral diseases, emphasizing the need for advanced technologies such as AI in preventive and diagnostic dentistry

Limitations and Ethical Concerns

Despite the promising applications of AI, several challenges remain.[1]

- **Data Privacy and Security**

AI systems require large datasets containing patient information. Maintaining patient confidentiality and ensuring secure data storage remain major concerns.

- **Algorithmic Bias**

AI models may produce biased results if trained on non-representative datasets. This may affect diagnostic accuracy across different populations.

- **Lack of Standardization**

The absence of standardized datasets and protocols limits the generalizability of AI systems.

- **Limited Clinical Validation**

Many AI models are still in experimental stages and require large-scale clinical validation before routine implementation.

- **High Cost and Technical Requirements**

The implementation of AI technologies may require significant financial investment, advanced infrastructure and technical expertise.

- **Ethical and Legal Issues**

Concerns regarding accountability, informed consent and decision transparency continue to challenge AI adoption in healthcare.

Future Perspectives

The future of AI in pediatric dentistry is highly promising. Integration with robotics, wearable devices, augmented reality and precision dentistry may further improve clinical outcomes.

Future developments may include:

- Fully automated diagnostic systems
- Real-time chairside AI assistance
- Predictive analytics for disease prevention
- Personalized oral healthcare models
- AI-assisted minimally invasive procedures
- Advanced teledentistry platforms
- Intelligent robotic systems for pediatric behaviour management

The development of explainable AI and standardized clinical protocols will be essential for broader acceptance and implementation.[1,2]

Conclusion

Artificial Intelligence is revolutionizing pediatric dentistry by enhancing diagnostic accuracy, improving treatment planning and optimizing patient management. Technologies such as machine learning, deep learning and computer vision have demonstrated significant potential in caries detection, age estimation, anomaly identification and radiographic interpretation.[15,16]

AI also contributes to improved patient experiences through virtual reality-based behaviour management and teledentistry applications. Although challenges related to ethics, privacy, validation and standardization remain, AI continues to evolve as a valuable adjunct in pediatric dental practice.

Rather than replacing clinicians, AI should be viewed as a supportive technology that complements clinical expertise and improves the quality of pediatric oral healthcare. Continued research, interdisciplinary collaboration and ethical integration are essential to maximize the benefits of AI in pediatric dentistry.

References

1. Ahmed N, Abbasi MS, Zuberi F, et al. Artificial intelligence techniques: analysis, application and outcome in dentistry – A systematic review. 2021.
2. Khanagar SB, Al-Ehaideb A, Maganur PC, et al. Developments, application and performance of artificial intelligence in dentistry – A systematic review. 2021
3. La Rosa S, Quinzi V, Palazzo G, Ronsivalle V, Lo Giudice A. The implications of artificial intelligence in pedodontics: a scoping review of evidence-based literature. InHealthcare 2024 Jun 30 (Vol. 12, No. 13, p. 1311). MDPI.
4. Alharbi N, Alharbi AS. AI-driven innovations in pediatric dentistry: enhancing care and improving outcome. Cureus. 2024 Sep 12;16(9).
5. Russell SJ. Artificial intelligence a modern approach. Pearson Education, Inc.; 2010.
6. La Rosa S, Quinzi V, Palazzo G, et al. Artificial intelligence in pediatric dentistry: A scoping review. 2024.
7. James D (2024) Artificial Intelligence in Pediatric Dentistry, a Systematic Review. J Dent Sci Med 7: 261.
8. Bishop CM, Nasrabadi NM. Pattern recognition and machine learning. New York: springer; 2006 Aug 17.
9. LeCun Y, Bengio Y, Hinton G. Deep learning. nature. 2015 May 28;521(7553):436-44.
10. Mallineni SK, Sethi M, Punugoti D, Kotha SB, Alkhayal Z, Mubaraki S, Almotawah FN, Kotha SL, Sajja R, Nettam V, Thakare AA. Artificial intelligence in dentistry: a descriptive review. Bioengineering. 2024 Dec 13;11(12):1267.
11. Lee JH, Kim DH, Jeong SN, Choi SH. Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. Journal of dentistry. 2018 Oct 1;77:106-11.
12. Karamüftüoğlu N, Üçpunar BY, Birben İ, Altundağ AE, Mullaoğlu KÖ, Bal C. Artificial Intelligence in Pediatric Dentistry: A Systematic Review and Meta-Analysis. Children. 2026 Jan 21;13(1):152.
13. Schwendicke FA, Samek W, Krois J. Artificial intelligence in dentistry: chances and challenges. Journal of dental research. 2020 Jul;99(7):769-74.
14. Tanna DA, Bhandary S, Hegde KS. Tech Bytes—Harnessing Artificial Intelligence for Pediatric Oral Health: A Scoping Review. International Journal of Clinical Pediatric Dentistry. 2024 Dec 19;17(11):1289.
15. Moses DE. Artificial Intelligence in Pediatric Dentistry: A.

16. Rahim A, Khatoon R, Khan TA, Syed K, Khan I, Khalid T, Khalid B. Artificial intelligence-powered dentistry: Probing the potential, challenges, and ethicality of artificial intelligence in dentistry. Digital health. 2024 Nov;10:20552076241291345.