# Artificial Intelligence-"A Tool for Augmentation and Advancement in Field of Pediatric Dentistry'': Review Article

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**Abstract**

In the global epidemic era, Oral problems significantly impact a major population of children. The key to a child's optimal health is early diagnosis, prevention, and treatment of these disorders. In recent years, the field of artificial intelligence [AI] has seen tremendous pace and progress. Artificial Intelligence [AI] is the development of computer systems that can do tasks that normally require human intelligence. A number of dental specialties, including pediatric dentistry, now use AI and its subsets, machine learning, and deep learning. Artificial Intelligence [AI] is transforming pediatric dentistry by enhancing diagnostic accuracy, streamlining treatment planning, and improving behavior management. This review explores current AI applications in detecting dental anomalies, categorizing fissure sealants, assessing chronological age, and managing patient behavior. AI-driven tools, such as machine learning algorithms, can analyze complex dental data, including radiographs, photographs, and clinical notes, to aid in early detection and management of oral diseases prevalent in children. AI facilitates tele dentistry, allowing remote consultations that expand access for underserved populations. Behavioral management tools engage young patients through interactive applications, making dental visits less intimidating. Overall, AI holds significant promise for improving outcomes and promoting better oral health in children. This paper presentation is a short review on artificial intelligence.

**Keywords**: Artificial Intelligence, Augmentation, Pediatric Dentistry, Publication

## Introduction

The idea of "Artificial Intelligence" (AI) was conceived in the year 1943, but the term was coined by John McCarthy at a conference in the year 1956, and the concept revolved around manufacturing machines that could replicate the tasks done by mankind. AI is a complex term to define, but in the larger sense, it is a machine algorithm that can reason out and execute cognitive functions. In dentistry, AI is used in several areas. It facilitates the early detection of dental caries, even in challenging cases, by analyzing radiographic and image data. AI algorithms can segment teeth, identify caries, and provide valuable predictions.[1] This current review includes original research publications on the application of AI models in pedodontics and pediatric dentistry. Articles without complete texts, narrative reviews, scoping reviews, letters to the editor, opinion letters, case reports, brief communications, conference proceedings, and non-English language articles (84 articles) were all omitted (Figure 1).[1] Finally, only 25 papers met the qualifying requirements.[3,7,10,20–41] P u b l i cations, conference proceedings, and non-English language articles (84 articles) were all omitted (Figure 1).[1] Finally, only 25 papers met the qualifying requirements.[3,7,10,20–41]



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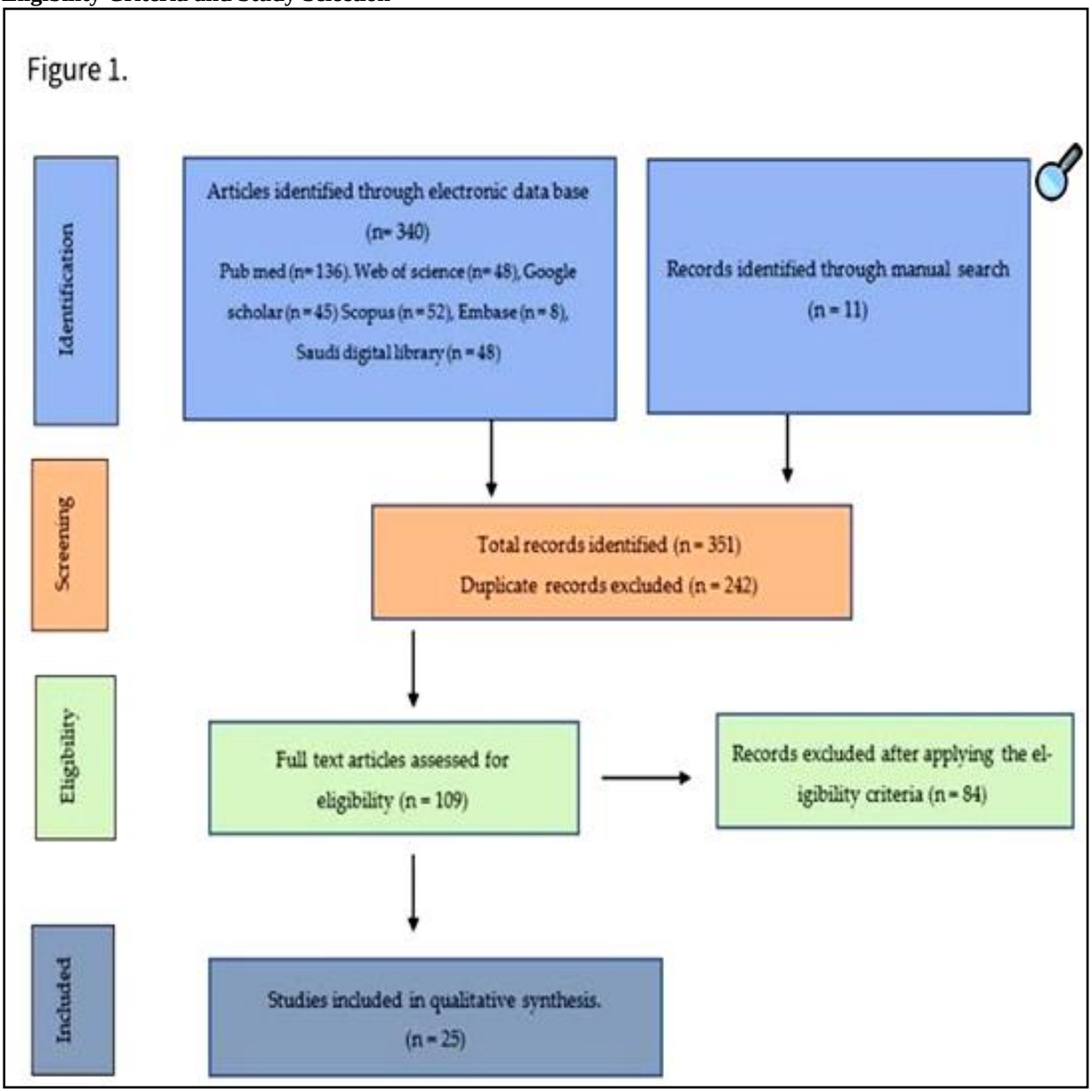
**Eligibility Criteria and Study Selection**

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AI models developed for application in pedodontics have mainly focused on dental plaque on primary teeth (n=1)[21],ECC (n=6)[25–30],fissure sealant categorization (n=1)[31], mesiodens and supernumerary tooth identification(n=6) [3,10,22–24,41], chronological age assessment (n=4)[32,33,37,38], identification of deciduous and young permanent teeth (n=3)[34,35,39], children's oral Health (n=2)[7,20], and ectopic eruption (n=2)[39,40] (Figure3).[1] AI in Pediatric Dentistry

The importance of pediatric dentistry cannot be overstated, as it serves as a cornerstone in establishing lifelong oral & general health habits. Early childhood experiences with dental care can significantly impact a child's oral well-being, affecting their overall health and quality of life.[1]



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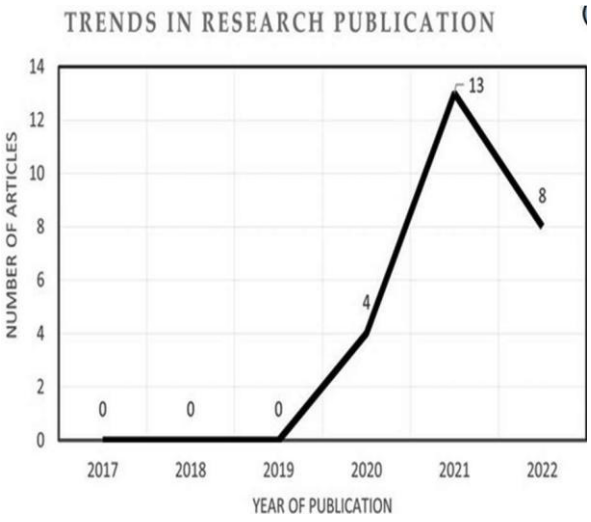
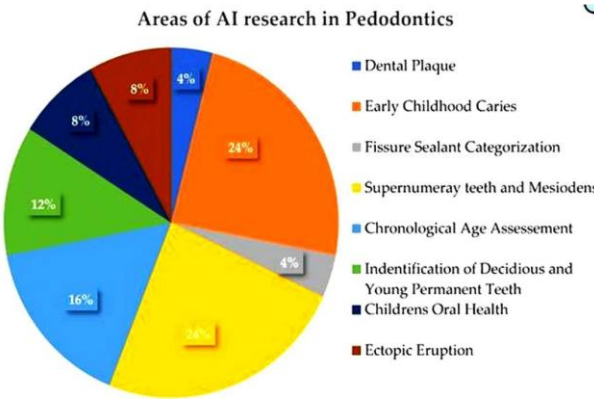
## Descriptive Analysis of the Included Studies

**Figure 2- Trends in Research Publication**




## Study Characteristics

**Figure 3- Areas of AI research in Pedodontics**




Diagnosis, in particular, has seen significant improvements through AI.[1] AI is a complex term to define, but in the larger sense, it is a machine algorithm that can reason out and execute cognitive functions. Nowadays, instead of the hand-crafted guidelines used in the past, machine learning (ML) and deep learning (DL) are two major branches of AI that are used in medicine. ML develops algorithms and statistical models using computers to improve cognition and understanding. It includes training algorithms on big datasets to detect patterns and utilize these patterns to forecast or decide upon fresh data. On the other hand, DL is a subset of machine learning that uses artificial neural networks to mimic the learning process of the human brain. They are trained using large amounts of data and algorithms and are more accurate. One class of DL is the Artificial Neural Network (ANN), which comprises tiny communicating units known as neurons that are arranged in layers; deep learning is nothing but an ANN with multiple hidden layers. A subclass of ANN, convolutional neural networks (CNN), is predominantly used in dentistry and general medicine.[1] AI-powered technologies like virtual reality (VR) and augmented reality (AR) alleviate fear and anxiety in pediatric patients, creating immersive and engaging experiences during dental procedures. Augmented Reality (AR) and Virtual Reality (VR) are immersive technologies that have gained prominence in various fields. A that are arranged in layers; deep learning is nothing but an ANN with multiple hidden layers. A subclass of ANN, convolutional neural networks (CNN), is predominantly used in dentistry and general medicine superimposes digital information onto the physical world, whereas VR generates immersive, simulated environments.[2] VR has emerged as an innovative tool, several techniques are utilizes to address anxiety, such as in vivo exposure therapy (IVET) and virtual reality exposure (VRET) AI in combination with emerging technologies such as Virtual Reality (VR) which can be used as a form of digital learning platforms can benefit more children and provide a personalized adoptive learning paradigm.[2]

**Figure 4**

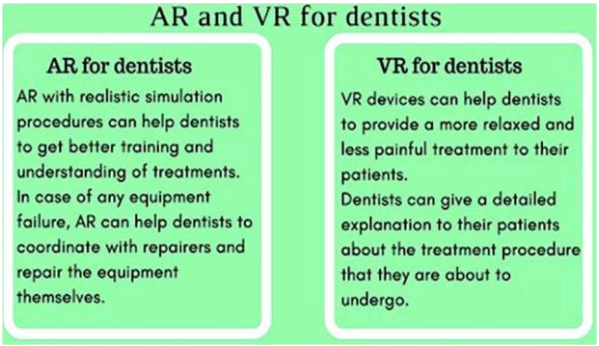
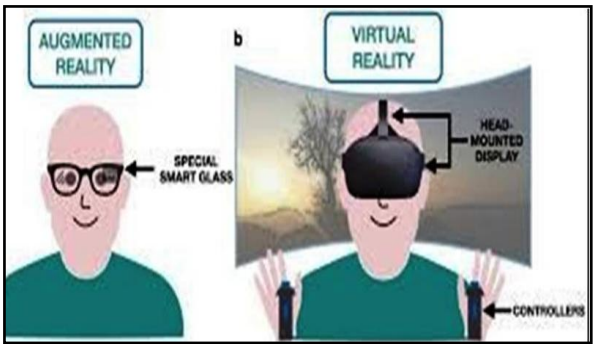



**Figure 5**




Aids in diagnosing common pediatric dental issues like cavities by analyzing X-Rays and intra oral images, providing valuable decision support to dentist. AI fundamentally changes how data is gathered, structured, and utilized, thereby enhancing the quality of care for children and adolescents. Its role in pediatric dental practices is pivotal, particularly in efficient data management. AI enables pediatric dentists to organize and centralized manner.



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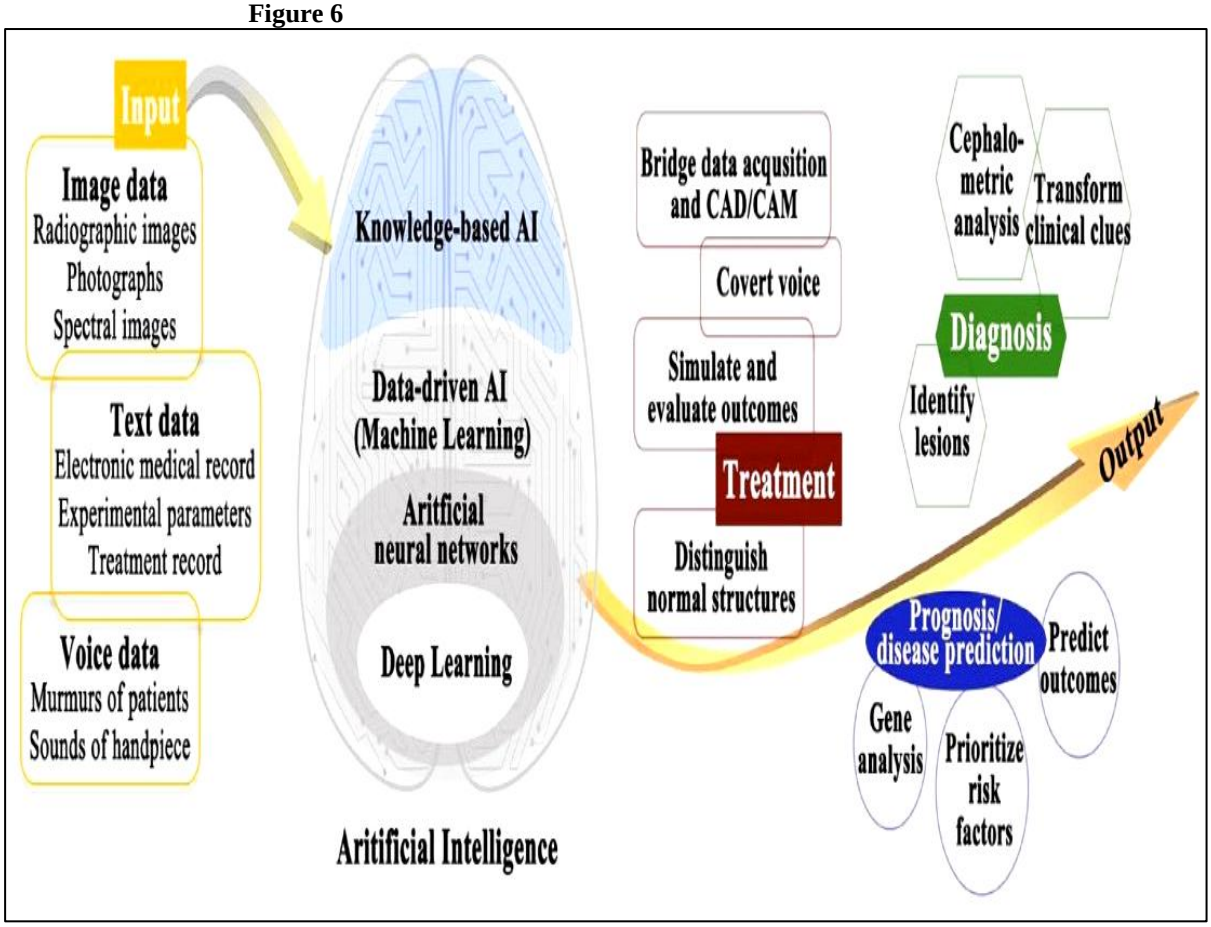
**In Diagnosis and Treatment Planning**

**Figure 6**




This capability supports the development of personalized and child-centered care plans.[3] Overall, AI fosters a collaborative approach in pediatric dental care by engaging both young patients and parents. By providing access to health data, age-appropriate educational resources, and decision support tools, AI ensures that children and their parents are well-informed partners in maintaining optimal oral health.[3] AI-driven devices, such as smart tooth brushes, allows parents and dentists to closely monitor a child's oral health between visits by providing real-time data on brushing habits and oral hygiene.[3] An advanced tool kit that utilizes Artificial Intelligence (AI). The AI-powered tool kit aims to collaborate with dental professionals, augmenting their ability to deliver comprehensive and personalized care for children's oral health.[3] AI Identifies potential risk factors in pediatric oral health. It revolutionizes how data are collected, organized, and utilized enhancing the quality of care provided to children and adolescents. AI's efficient data management capabilities provide pediatric dentists with a structured and centralized system for organizing the extensive medical records of children. This ensures quick access to crucial information about a child's dental history, allowing for more Wang, Y. et al.[4] have pioneered the development of a comprehensive tool kit utilizing AI for the assessment of a child's oral health. Personalized and child-centric care plans.[3]

In the field of dental diagnostics, the identification and numbering of teeth using dental radiographs are fundamental tasks. Similarly, a tooth classification and numbering approach using image enhancement techniques has been created, demonstrating effectiveness even with challenging images. Recent advancements in tooth localization have increasingly utilized deep learning, particularly Convolutional Neural Networks (CNNs). A recent study developed a Faster R-CNN model with the Google Net Inception v2 architecture to detect and number deciduous teeth in pediatric panoramic radiographs, representing the first model to accurately detect and number each primary tooth in children, demonstrating high performance and significant potential for advancing pediatric dental diagnostics.[3] Note worthy advancements in estimating the chronological age of children and adolescents aged 4 to 15. This ground-breaking approach employs digital pantomographic images and a novel set of tooth and bone parameters to create an innovative age assessment methodology.



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**In Assessing Child's Oral Health**

**Figure 7**


In order to establish the chronological age of children and adolescents between the ages of 4 and 15, Zaborowicz, M.[4] et al. employed three deep NN models. Their findings demonstrated that neural modeling algorithms could accurately determine metric age utilizing proprietary teeth and bone indicators. Pediatric kids' deciduous teeth are increasingly being evaluated and counted using deep learning techniques like CNN. R-CNN inception has demonstrated good tooth identification accuracy. The first permanent molar ectopic eruption has been accurately identified by AI. According to Bulatova et al.,[4] the AI-based model was more efficient at identifying cephalometric landmarks than manual tracing. The incorporation of Artificial Intelligence (AI) in early childhood caries (ECC) exhibits considerable potential for precise prediction and diagnosis. An automated machine learning (AutoML) system has been designed to classify children based on their ECC status, showing effectiveness in resource-limited settings when including age and parent-reported oral health status.[3,4] The incorporation of Artificial Intelligence (AI) in early childhood caries (ECC) exhibits considerable potential for precise prediction and diagnosis.

Research studies have demonstrated that machine learning algorithms can accurately forecast ECC and caries risk across diverse populations, displaying high levels of accuracy, sensitivity, specificity, and area under the curve (AUC) values. The implementation of these tools is crucial for initiating targeted preventive measures and optimizing clinical decision-making in dental caries management.[3,4] AI is rapidly transforming pediatric restorative dentistry, offering numerous benefits such as increased efficiency, precision, and improved aesthetics. Central to this transformation is computer-aided design and computer aided manufacturing (CAD/CAM) technology, which has become essential in restorative procedures for children.[3] One of the main advantages of AI-enabled CAD/CAM technology in pediatric restorative dentistry is the significant reduction in treatment time. Young children often struggle with lengthy dental procedures, and shorter treatment sessions are better tolerated. AI-driven CAD/CAM systems streamline the restoration process, enabling faster and more efficient treatments. Additionally, this technology helps create custom-



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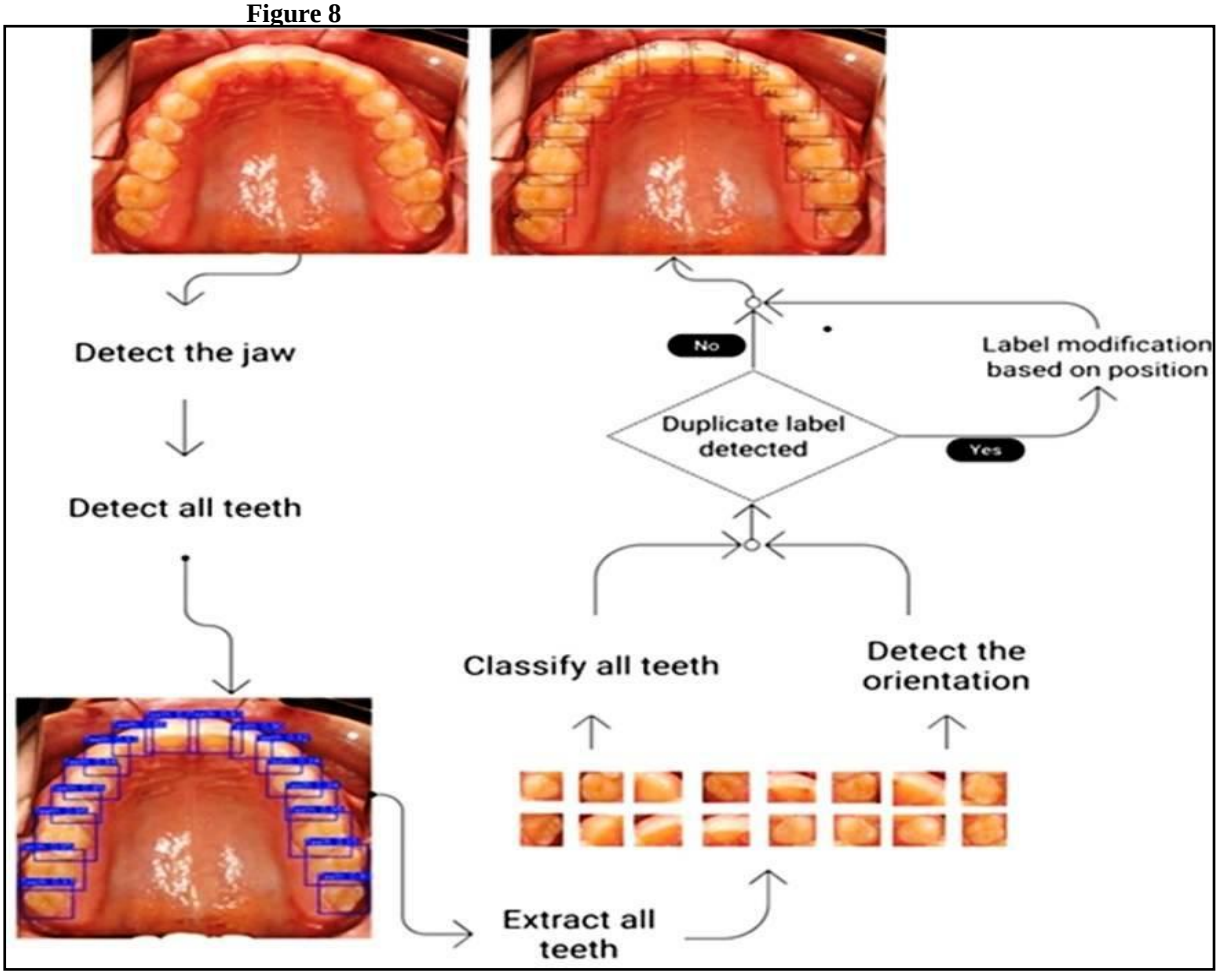
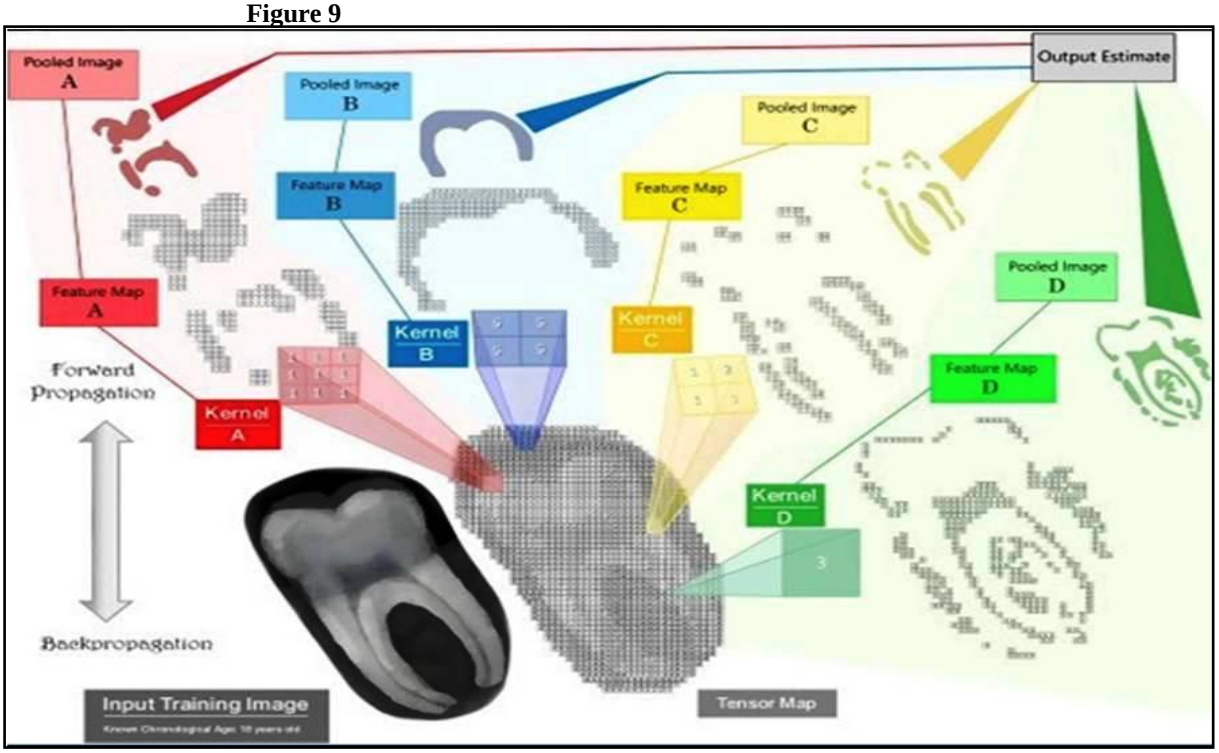
**In Detecting Deciduous Teeth**

**Figure 8**




**In Assessing Chronological Age**

**Figure 9**



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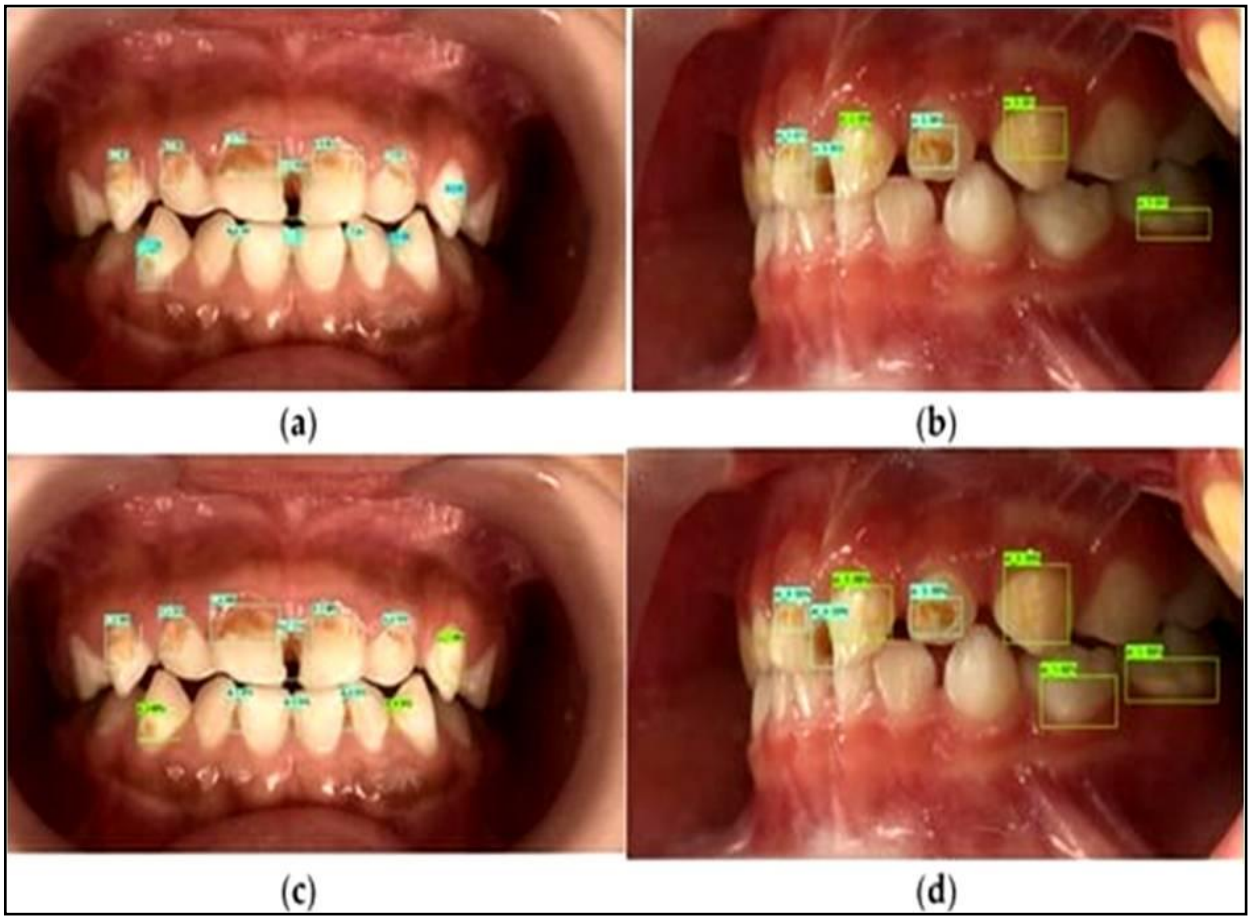
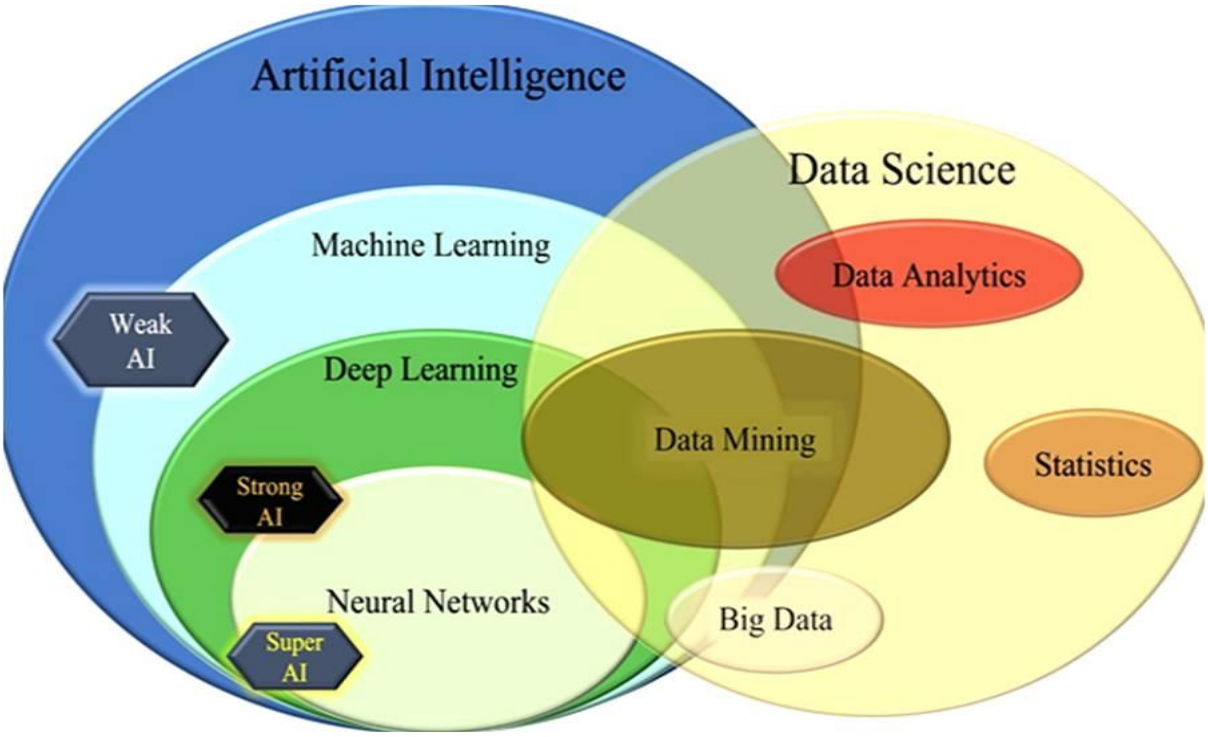
**AI in Early Childhood caries**

**Figure 10**




**AI in Pediatric Restorative Dentistry**

**Figure 11**



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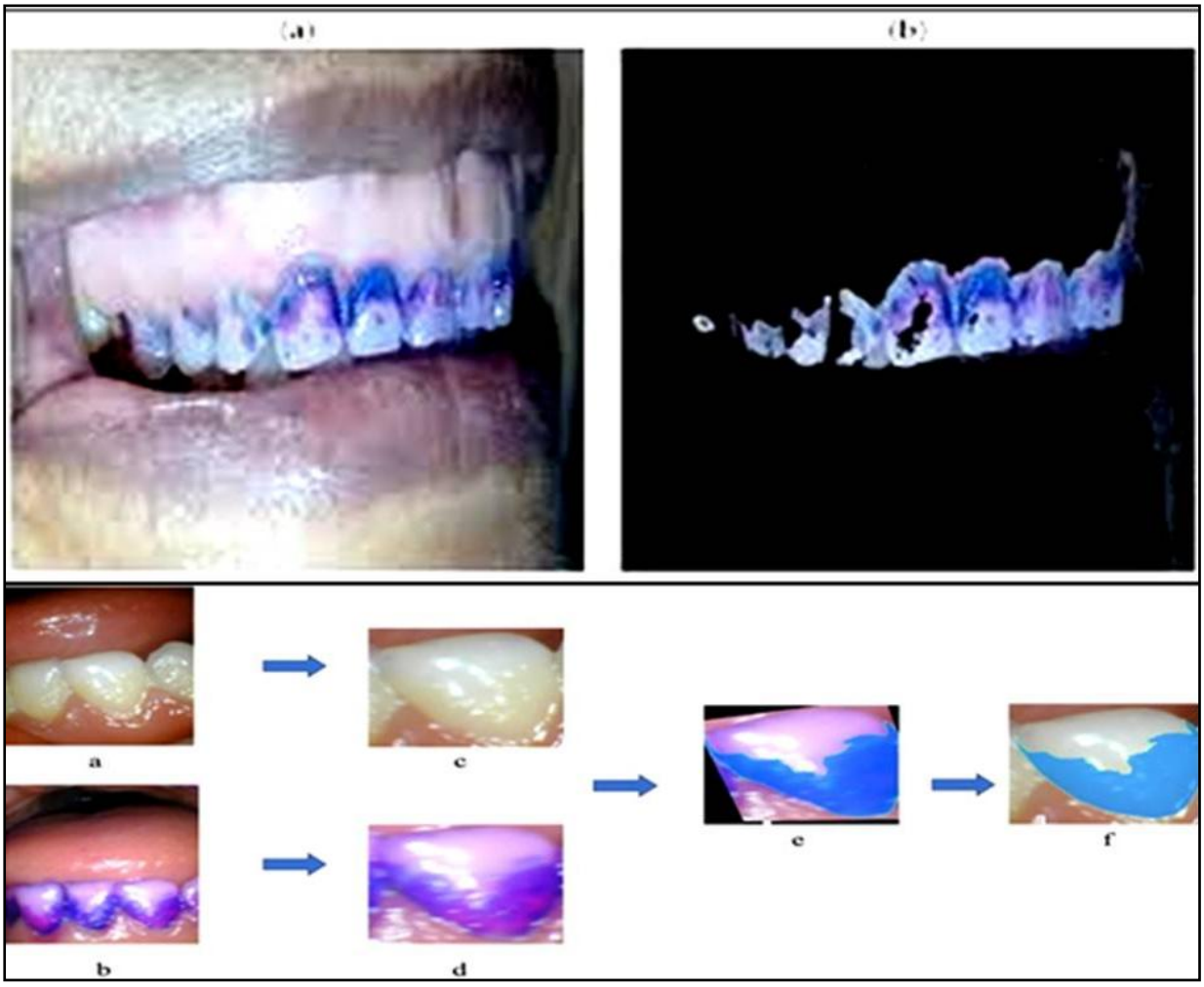
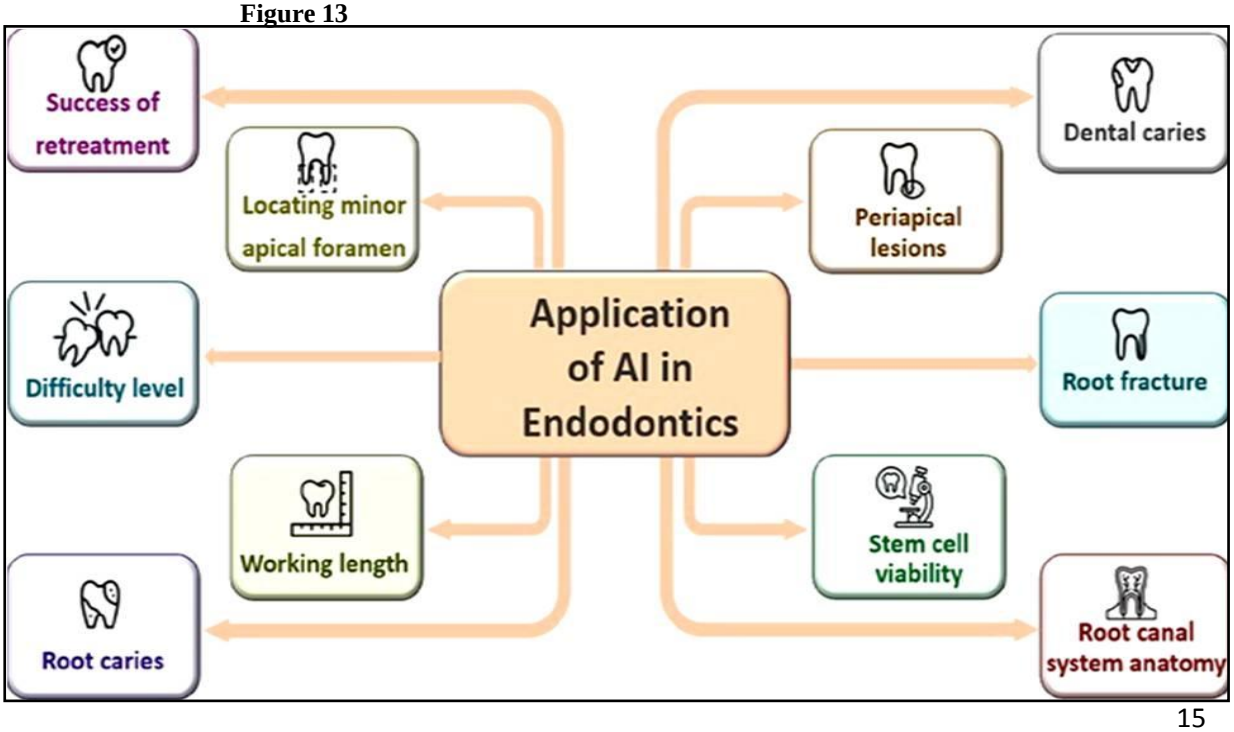
**AI in Detection of Plaque**

**Figure 12**




**AI in Endodontics**

**Figure 13**



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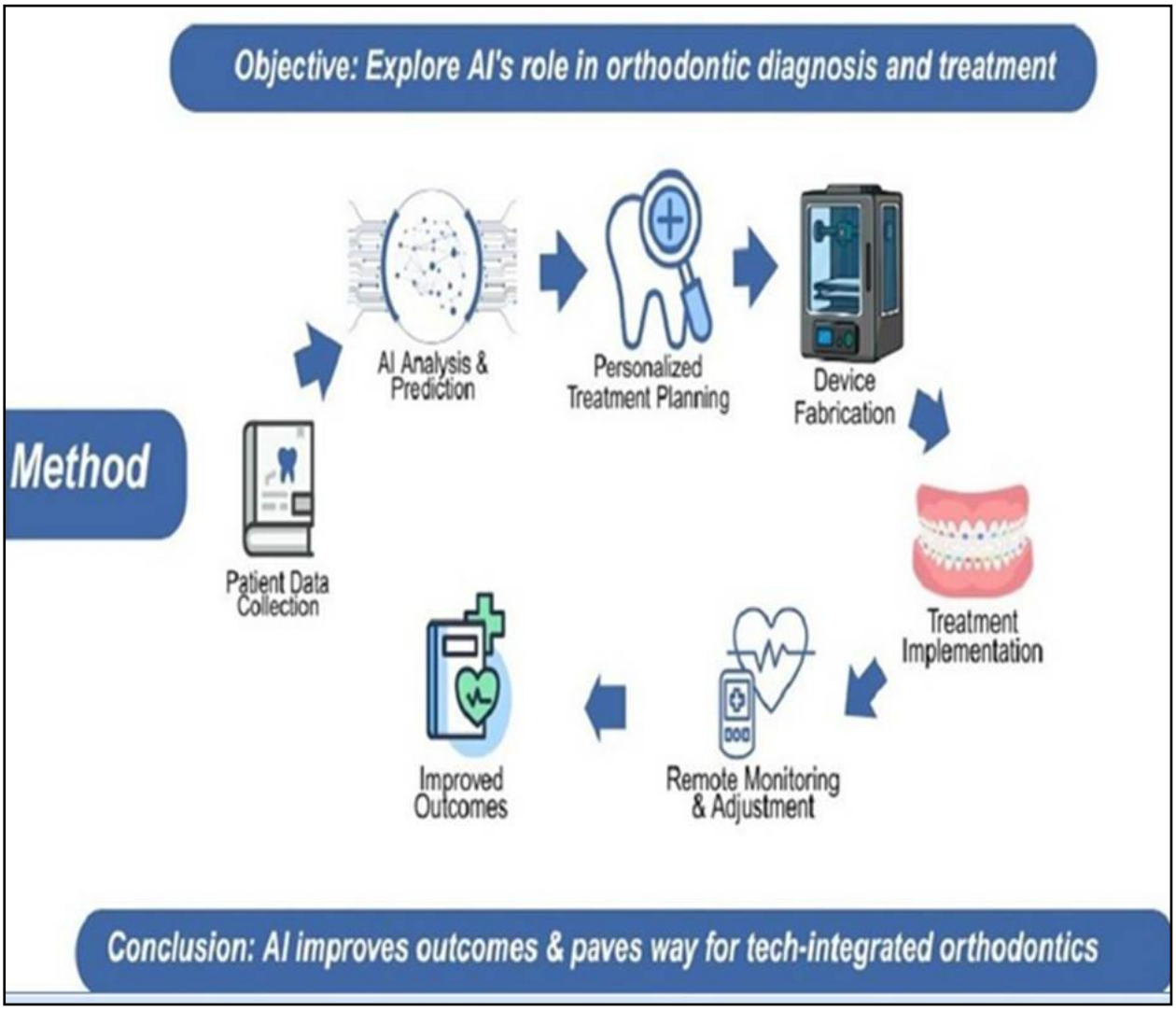
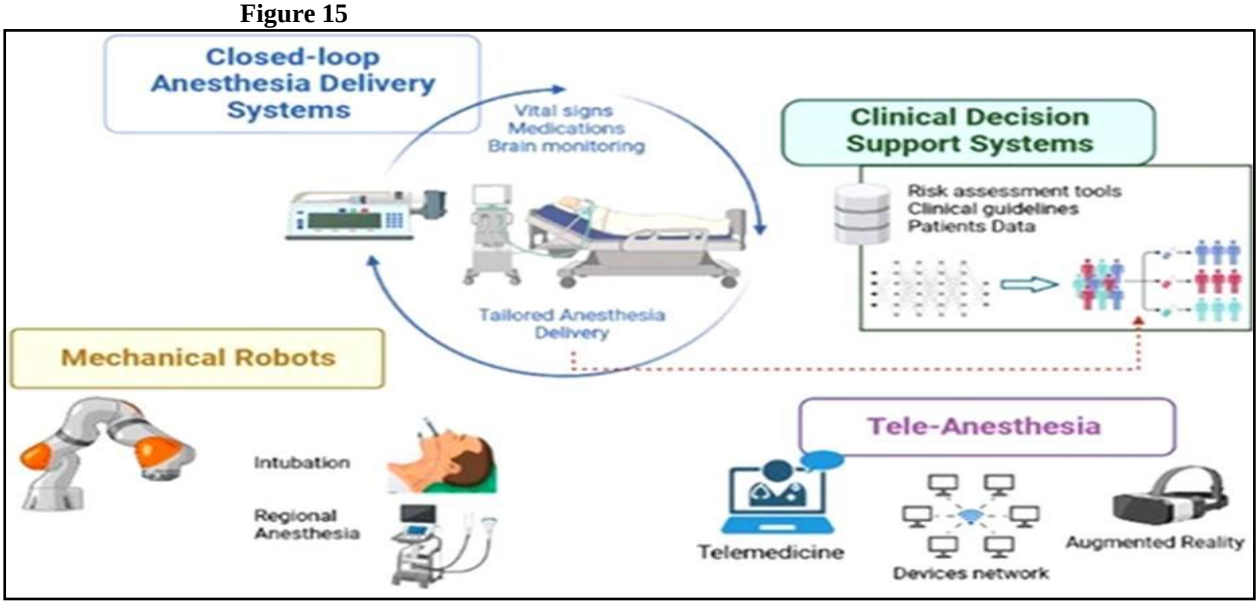
**AI in Orthodontics**

**Figure 14**




**AI in Local Anesthesia**

**Figure 15**



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made restorations that perfectly fit a child's dental anatomy, enhancing treatment outcomes, reducing discomfort, and minimizing the need for multiple visits.[3] AI-based deep learning techniques for identifying plaque-affected primary teeth are a major leap forward in pediatric dentistry was implemented. Using a Convolutional Neural Network (CNN) framework, their research is poised to transform plaque detection and management in primary teeth.[3] A significant advantage of AI in plaque detection is its ability to rapidly analyze a large number of tooth images, saving valuable clinical time and allowing for more frequent and thorough examinations. Early detection and monitoring of plaque progression enable the implementation of effective preventive measures. Additionally, the continuous monitoring of plaque and dental health is a potential area for further expansion. AI can track changes in plaque status over time, allowing dentists to provide personalized recommendations for improved oral hygiene and preventive care.[3] The integration of Augmented Reality (AR) into dentistry is heralding a new era of improved visualization and patient engagement. AR technology in dentistry offers numerous benefits. It allows dentists to overlay detailed anatomical structures, like root canals, directly onto the patient's oral cavity in real-time, eliminating the need to constantly reference separate screens.[3] AI can be helpful in evaluating the anatomy of the root canal system, identifying working length measures, diagnosing periapical diseases and root fractures, and forecasting the outcome of retreatment treatments. When testing three different CNNs for the diagnosis of pulpitis and deep caries on intraoral periapicals, Zheng et al.[4] discovered that the multimodal CNN performed well in terms of accuracy. Orthodontics, in particular, has significantly benefited from the combination of AI-driven appliances and AR technology. Personalized AI-driven appliances, designed to be more appealing to younger patients, are becoming increasingly popular. These appliances are customized to meet individual needs, making orthodontic treatment more engaging. AI algorithms combined with AR technology create personalized treatment plans and appliances, enhancing efficiency and patient-centered care. AI ensures precision and predictability in orthodontic treatment planning and appliance design by analyzing extensive datasets and recommending tailored treatment strategies.[3] AR complements this by allowing orthodontists to visualize expected treatment outcomes and communicate them effectively to patients. It also supports remote monitoring, enabling patients to use AR powered apps to capture images of their teeth, allowing orthodontists to assess progress and provide remote guidance, thus reducing the need for frequent in-person visits.[3] AI technology can significantly improve the quality of sonographic images used in guiding local anesthesia procedures. By processing and enhancing images, AI algorithms can increase the clarity and visibility of anatomical structures, making it easier for medical professionals to accurately identify the target area for anesthesia.[3] Enhanced image quality results in more precise injections, reducing the likelihood of complications. The integration of AI in local anesthesia not only aids medical professionals but also enhances the overall patient experience. AI-guided procedures tend to be more accurate, leading to less discomfort, quicker recovery times, and fewer complications. Consequently, patients can feel more assured about the safety and effectiveness of local anesthesia, fostering a more positive view of pediatric dentistry procedures.[3]

**Drawbacks of using AI in pediatric dentistry, particularly in behavior management[2]**

1. Lack of Personalized Interaction
2. Limited Adaptability to Child's Behavior
3. Loss of Human Touch and Comfort
4. Unpredictable Reactions to AI Tools
5. Misinterpretation of Nonverbal Cues
6. Ethical and Safety Concerns
7. Dependency on Technology
8. Complexity of Procedures
9. Parent-Child Relationship
10. Limited Learning from Experience

## Conclusion

In conclusion, the potential integration of AI in pediatric dentistry offers opportunities and challenges that warrant careful consideration. While AI technologies hold promise in enhancing certain aspects of dental care, it is essential to acknowledge the complexity of pediatric dentistry and the unique needs of young patients**.** Cautious optimism should guide the integration of AI into pediatric dentistry. By acknowledging its strengths while remaining attentive to its limitations, the pediatric dental community can ensure that advancements in technology enhance, rather than replace, the vital human connections that define the practice of pediatric dentistry.

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