# Artificial Intelligence in Pediatric Dentistry

## *Çocuk Diş Hekimliğinde Yapay Zeka*

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**ABSTRACT**

*Artificial intelligence (AI) has become a transformative tool in various fields. This comprehensive review examines the innovative applications of AI in pediatric dentistry, emphasizing its potential to enhance patient care, facilitate accurate diagnosis, optimize treatment planning, and advance dental education.*

*Furthermore, the integration of virtual reality (VR) and augmented reality (AR) technologies offers immersive educational experiences that not only aid in educating children about dental procedures but also play a crucial role in reducing dental anxiety.*

**Keywords:** *Artificial Intelligence, Pediatric Dentistry, Virtual Reality*

**ÖZ**

*Yapay zeka (YZ), farklı alanlarda dönüştürücü bir araç olarak dikkati çekmektedir. Bu derleme makalesi, yapay zekanın çocuk diş hekimliğinde yenilikçi uygulamalarını sunmakta ve yapay zekanın hasta bakımı, tanı, tedavi planlaması ve eğitimde yerini vurgulamaktadır.*

*Sanal gerçeklik (SG) ve artırılmış gerçeklik (AG) uygulamaları, sürdürülebilir eğitim deneyimleri sunarak çocuklarda diş hekimliği uygulamalarının kabul edilebilir hale gelmesine ve kaygının azalmasına yardımcı olmaktadır.*

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## INTRODUCTION

The field of Artificial Intelligence (AI) is a relatively recent development in both engineering and science, concerned with the imitation of intelligent behaviour and the creation of artefacts that replicate such behaviour.[1-6] The integration of AI into diverse sectors has been a subject of considerable interest. Information technology (IT) in the field of dentistry has undergone significant expansion over the past 25 years, contributing to a reduction in costs, time, reliance on human expertise, and medical errors. As a subfield of computer science, AI encompasses hardware and software capable of perceiving its environment and taking actions that maximize its chances of successfully achieving its goals. The integration of AI into the dental field has the potential to enhance patient health outcomes while reducing costs, thereby facilitating the delivery of personalized, preventative, and predictive dentistry services that can be made universally accessible. The potential of AI to enhance dental care is evident in its capacity to refine diagnostic accuracy and efficacy, generate more precise visualizations for treatment, simulate outcomes, and predict oral diseases and health.[7-10]

Pediatric dentistry is a field that constantly seeks innovative ways to provide the best care for children's oral health. With the rapid advancement of technology, AI has emerged as a promising tool to enhance various aspects of pediatric dental care. From the initial diagnosis to the formulation of treatment plans and the education of patients, AI is profoundly transforming the manner in which dentists approach the field of pediatric oral health.[3,8,9]

Artificial intelligence holds immense promises for pediatric dentistry, offering opportunities to improve diagnostics, treatment planning, patient experience, and practice management. As research and development in this field continue to advance, clinicians, researchers, and administrators need to collaborate in harnessing the full potential of AI while addressing associated challenges to ensure equitable access and ethical use in pediatric dental care. With its ability to process vast amounts of data, recognize patterns, and make predictions, AI is revolutionizing oral healthcare in numerous ways. This review explores the applications of AI in dentistry, its benefits, challenges, and prospects.[11-17]

### The Use of AI in Pediatric Dentistry

The use of AI in Pediatric Dentistry is quite relevant because it not only requires skill to perform procedures but also requires proper behavior guidance skills.[11-13] Innovations in pediatric dentistry are being introduced with the aim of facilitating the identification of patients' behavioural patterns, as well as the management of their anxiety, the management of data, investigations, diagnosis, treatment planning, prognosis and patient education. It benefits clinicians with high-quality patient care and simplifies complicated protocols by providing a predictable outcome.[11-17]

### Early Detection, Diagnosis, and Treatment Planning

One of the most significant contributions of AI in pediatric dentistry is its ability to aid in the early detection and diagnosis of dental issues. AI-based image recognition systems can analyze dental images, such as X-rays and intraoral scans, with remarkable accuracy. These systems can detect dental caries, developmental abnormalities, and other oral health problems at their earliest stages, allowing for timely intervention and prevention of further complications. This aids in early diagnosis and precise treatment planning.[13-16]

AI algorithms can analyze vast amounts of patient data, including medical history, dental records, and diagnostic images, to develop personalized treatment plans for pediatric patients. By considering individual factors such as age, oral hygiene habits, and risk factors, AI can recommend the most appropriate interventions, such as topical fluoride applications, sealants, or orthodontic procedures, tailored to each child's unique needs.[9,14]

### Chronological Age Assessment

It has been focused on producing a new method for detecting the chronological age using digital panoramic radiographs. This method is simpler, has near-perfect accuracy, and was one of the first to use radiographs for metric age assessment.[13,14,18]

### Virtual Simulation and Education

Virtual reality (VR) and augmented reality (AR) technologies powered by AI are transforming the way children learn about oral hygiene and dental procedures. Interactive VR simulations allow young patients to explore virtual dental environments, familiarizing them with dental instruments and procedures in a fun and engaging way. AR applications can also educate children about proper brushing techniques and oral hygiene practices, encouraging them to develop lifelong habits for optimal oral health.[2,9,11]

### Predictive Analytics and Preventive Care

AI-based predictive analytics can forecast future dental issues based on historical data and risk factors, enabling dentists to implement preventive measures before problems arise. By identifying high-risk patients

and recommending targeted preventive interventions, such as dietary modifications or fluoride supplementation, AI helps mitigate the risk of dental caries and other common pediatric dental problems.[3,8,15,19-21]

### Local Anesthesia

The new, better path to injection-free pediatric dentistry practice is pain control with AI-based devices. In children, anesthetic 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 decided by the dentist when he/she can command the robots to deactivate.[6,8]

### Restorative Dentistry

AI-based restorative dentistry with computer-aided design and computer-aided manufacturing technology is well-established, and it would be a time and aesthetic benefit for pediatric restorations.[22-30]

### Endodontics

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. This allows the dentist to obtain critical information such as the complex anatomy of root canals while maintaining focus on the operating field in contrast to the conventional systems.[31-33]

### Orthodontics and Prosthodontics

Orthodontic diagnosis, planning, and treatment monitoring are possible using AI. Analysis of radiographs and images taken by intraoral scanners and cameras can be used for diagnosis and treatment planning. Designing software has been a great aid to orthodontists in fabricating the best possible aesthetics for patients considering all the variables like measurements of the face, anthropological computation, and even the patient's desire.[7,8,34,35]

The computer-guided digital impression is another useful application of artificial intelligence. They are not only faster and more accurate but also laboratory procedures are eliminated, greatly reducing human mistakes.[2,36]

CAD/CAM technique helps to create three-dimensional models and aids in the manufacturing of inlays, onlays, crowns, and bridges. This technique has greatly reduced human efforts on time-consuming laboratory procedures, also reducing the errors in final prosthesis.[3,35,37]

### Benefits of AI in Dentistry

**Improved Accuracy:** AI algorithms can analyze data with unparalleled precision, reducing diagnostic errors and ensuring optimal treatment outcomes.

**Efficiency:** The utilization of AI in the automation of routine tasks has been demonstrated to liberate time for dentists to concentrate on more complex cases and patient care, thus enhancing overall productivity.

**Cost-effectiveness:** AI-based preventive care can mitigate the need for expensive treatments by addressing dental issues at an early stage, reducing healthcare costs in a long-term period.

**Enhanced Patient Experience:** Personalized treatment plans and efficient appointment scheduling contribute to a more satisfying patient experience, fostering loyalty and trust.[3,8,9,20,38,39]

### Challenges and Ethical Considerations

Despite its numerous benefits, the integration of AI in pediatric dentistry presents some challenges and considerations. Privacy and security concerns regarding the storage and handling of sensitive patient data must be addressed to ensure compliance with healthcare regulations. Additionally, there is a need for ongoing training and education to familiarize dental professionals with AI technologies and ensure their effective implementation in clinical practice.

**Data Privacy:** AI systems rely on vast amounts of patient data, raising concerns about privacy and security breaches.

**Bias and Fairness:** Biases in AI algorithms can lead to disparities in treatment recommendations and patient care, necessitating careful algorithm development and validation.

**Regulatory Compliance:** The integration of AI in dentistry requires adherence to regulatory standards and guidelines to ensure patient safety and ethical practice.[8,9,20,35,40]

Despite the promising results of the presented AI models, it is still necessary to verify their generalizability and reliability using appropriate external data obtained from patients or accumulated from other dental facilities. Future aims of AI research in dentistry include not only raising the performance of AI models to expert levels but also detecting early lesions that are invisible to humans.

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