REVIEW ARTICLE

CONTENTS

Possibilities of using artificial intelligence in orthodontics (literature review)

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ABSTRACT

Aim: to review and analyze scientific and medical information on artificial intelligence in orthodontic dentistry.

Materials and Methods: A review and analysis of scientific and medical literature on the application of artificial intelligence in orthodontic dentistry was conducted. The literature search was carried out in the Scopus, Web of Science, and Google Scholar databases. The following combinations of keywords were used: "artificial intelligence in orthodontics", "3D planning orthodontics", and "machine learning in orthodontics". Inclusion criteria: publications from 2020–2025; original studies (clinical and experimental); the use of AI in diagnosis, planning, or treatment in orthodontics. Exclusion criteria: systematic reviews (considered only in the introduction), commentaries, expert opinions, and studies without a description of the practical use of AI. Search results: 312 articles were found; after removing duplicates — 238; after analyzing titles and abstracts — 82; a total of 12 articles were included in the final analysis.

Conclusions: Artificial intelligence represents a promising tool in orthodontics, enhancing diagnostic accuracy, optimizing treatment planning, and improving outcome prediction. The integration of multimodal data supports comprehensive patient assessment and individualized treatment strategies.

KEY WORDS: artificial intelligence, orthodontics, 3D planning, treatment planning

Wiad Lek. 2026;79(5):1100-1103. doi: 10.36740/WLek/220838 DOI

INTRODUCTION

The use of innovative technologies in orthodontics includes the potential of software to optimize various processes, transforming the appearance of medical care and ensuring its rapid integration into dentistry. The ability to quickly and accurately analyze large amounts of data is one of the most significant advantages of artificial intelligence, which, in turn, facilitates clinical decision-making for dental practitioners in various clinical situations.

Orthodontists, with the aid of artificial intelligence, can provide customized solutions for each patient. This is the foundation of treatment prediction. However, this does not change the fact that specialists in this field, using their acquired knowledge and experience, remain responsible for establishing an accurate diagnosis and selecting the optimal treatment plan [1-8].

In connection with the active implementation of digital technologies in healthcare, machine learning tools are increasingly used as effective means for processing large-scale patient data. These algorithms provide automated classification, interpretation, and prediction based on both structured and unstructured medical data, thereby accelerating clinical decision-making. An essential advantage of such technologies is their ability to be integrated into medical documentation systems — either as fully autonomous solutions or with varying degrees of user involvement. This provides physicians with flexibility in selecting the optimal tool that best suits the specifics of their clinical practice, ensuring seamless integration into their existing workflow.

The further development of cloud computing has opened new perspectives for organizing medical documentation in an online environment. Cloud platforms enable the storage, processing, and analysis of medical data on remote servers with high computational capacity and cybersecurity. The main advantages of these systems include: (1) no need for expensive local equipment, (2) high scalability and performance, and (3) the possibility of cross-platform access from various devices — including desktop computers, laptops, tablets, and smartphones — which is particularly relevant for

multidisciplinary clinics with extensive networks. Collectively, this allows healthcare institutions to optimize document management, reduce costs, and improve the accessibility of medical information for all participants in the care delivery process [1, 4, 6].

Furthermore, intelligent algorithms enable the prediction of treatment duration, assessment of the likelihood of achieving planned outcomes, modeling of the long-term stability of treatment results, and identification of potential risks and complications even before therapy initiation. This level of personalization contributes to the development of individualized orthodontic protocols based on objective data. As a result, the implementation of AI-based approaches in clinical practice increases patient engagement in decision-making, improves their understanding of treatment measures and expected outcomes, and overall contributes to achieving predictable and long-term results [1, 3, 5, 8].

AIM

To review and analyze scientific and medical information regarding the application of artificial intelligence in orthodontic dentistry.

MATERIALS AND METHODS

A review and analysis of scientific and medical literature on the application of artificial intelligence in orthodontic dentistry was conducted. The literature search was carried out in the Scopus, Web of Science, and Google Scholar databases. The following combinations of keywords were used: "artificial intelligence in orthodontics", "3D planning orthodontics", and "machine learning in orthodontics".

The selected keywords encompassed both general AI applications and specific areas, including prediction, 3D modeling, treatment planning, and patient interaction. This ensured the selection of relevant studies corresponding to the topic of the review.

Inclusion criteria: publications from 2020–2025; original studies (clinical and experimental); the use of AI in diagnosis, planning, or treatment in orthodontics.

Exclusion criteria: systematic reviews (considered only in the introduction), commentaries, expert opinions, and studies without a description of the practical use of AI.

Search results: 312 articles were found; after removing duplicates — 238; after analyzing titles and abstracts — 82; a total of 12 articles were included in the final analysis.

ETHICS

All sources used in this literature review are publicly available.

REVIEW AND DISCUSSION

The application of AI in orthodontics can be divided into several main areas:

1. Diagnosis and Prediction

• Baxi et al. (2022, India): demonstrated that AI algorithms can improve diagnostic accuracy of dentoalveolar anomalies, reducing subjective clinician bias.

• Gupta (2020, India): explored AI capabilities for X-ray and CT image analysis; found accuracy challenges in complex cases.

• Tsolakis et al. (2022, Greece): confirmed in a systematic review the effectiveness of AI in CBCT airway analysis, improving measurement accuracy and reducing diagnostic time.

2. Treatment Planning

• Elnagar et al. (2020, USA): developed an AI-assisted digital workflow for orthognathic surgery, which reduced inaccuracies and accelerated planning.

• Caruso et al. (2021, Italy): automated treatment monitoring allowed timely protocol adjustments.

3. Patient Interaction

• Thurzo et al. (2022, Slovakia): investigated the use of smartphones for 3D facial scanning with AI algorithms, making the procedure accessible outside the clinic.

• Gandedkar et al. (2021, Australia): studied AR/VR simulations with AI elements that improve patient understanding of treatment prognosis and enhance motivation.

4. Innovative Approaches

• Prasad et al. (2023, USA): integration of wearable sensors with AI algorithms for monitoring muscle activity during orthodontic treatment.

PREDICTIVE ANALYTICS AND OUTCOME ASSESSMENT

Prediction of treatment duration. AI algorithms consider both clinical and individual patient characteristics, including tooth movement dynamics and compliance levels, enabling more accurate predictions of treatment duration. This enhances patient satisfaction by reducing overall treatment time and allowing for the visualization of results in 3D models [1, 2, 4].

ASSESSMENT OF TREATMENT SUCCESS

The success of orthodontic treatment is determined by multiple factors. Comparing actual outcomes with predicted ones (final tooth position, occlusion, dura-

tion) allows for an objective assessment of treatment effectiveness. In cases of significant deviations, AI assists the clinician in identifying their causes and making necessary adjustments to future protocols [1, 6, 9].

ANALYSIS OF LONG-TERM STABILITY

AI enables the prediction of relapse risk after treatment completion, taking into account bone density, anatomical features, and previous results. This facilitates the development of individualized retention programs and the timely detection of changes affecting treatment stability [7, 11].

PATIENT INTERACTION AND ENGAGEMENT

VIRTUAL CONSULTATIONS AND FOLLOW-UP

Modern telemedicine platforms, integrated with AI, provide remote monitoring, video consultations, and seamless data exchange. This reduces the number of in-office visits while maintaining treatment quality [1, 10].

PERSONALIZED PROGRESS TRACKING

Mobile applications allow patients to visualize treatment dynamics in 3D models and receive reminders about appointments, improving motivation and adherence to treatment protocols [1, 10, 12].

GAMIFICATION AND AR/VR

Game-based elements (bonuses, tasks) in mobile applications encourage compliance with recommendations. VR/AR technologies demonstrate predicted dentoalveolar changes, help reduce anxiety, and increase patient engagement [10, 12].

The results of the study demonstrate that artificial intelligence is a reliable tool that makes orthodontic treatment more predictable — specifically, faster, more cost-effective, and more convenient. In recent years, AI has become increasingly popular in modern dentistry. Artificial intelligence is now widely applied in diagnostics, treatment planning, and various orthodontic procedures.

Currently, AI technologies have not yet become a leading instrument in everyday practice. However, it is worth noting that although AI cannot fully replace human intelligence, it can significantly enhance treatment outcomes and clinical efficiency in this field. Nevertheless, artificial intelligence in orthodontics still requires further refinement, especially in diagnostic processes, to achieve higher precision and effectiveness in daily orthodontic practice [1, 3, 9, 10].

CONCLUSIONS

Artificial intelligence in orthodontics is applied for diagnostics, prediction, and treatment planning. Its use enhances the accuracy and speed of clinical decision-making but does not replace the physician. The most promising directions include automated diagnostics, 3D planning, and remote monitoring.

The main advantages are accuracy, speed, and personalization; the main limitations include cost and the need for algorithm standardization.

Future research should focus on clinical validation, cost optimization, and the integration of AI into daily orthodontic practice.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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RECEIVED: 16.01.2026
ACCEPTED: 23.04.2026