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DIGITAL TRANSFORMATION OF ORTHODONTICS USING ARTIFICIAL INTELLIGENCE

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Relevance. Artificial intelligence (AI) is becoming a key tool in digital orthodontics. The automation of diagnosis, prediction, and treatment monitoring increases accuracy, reduces errors, and accelerates clinical processes.

Objective of the study. To conduct a review of scientific literature (2019–2026) on the application of AI in orthodontics and to identify the main directions of digital transformation in orthodontic practice.

Materials and Methods. Sources: eLIBRARY, Scopus, Google Scholar, PubMed/MEDLINE, ResearchGate, and MDPI. A total of 10 English-language publications were selected. Keywords: orthodontics, artificial intelligence, machine learning, deep learning, neural networks, 3D modeling.

Main Results

- *Identification of causes of dentofacial anomalies:* AI enables the detection of adenoid hypertrophy and assessment of the risk of obstructive sleep apnea (OSA). High accuracy of cephalometric radiograph analysis has been confirmed by studies (accuracy up to 88–95%).
- *Photometry and photodiagnostics:* CNNs achieved classification accuracy of anomalies up to 98% based on facial and intraoral images. The YOLO model fully automated the assessment of the need for orthodontic treatment. AI analysis speed exceeds manual processing by 236 times.
- *3D facial scanning:* Integration of 3D scans, photographic data, and cephalometry to create a "virtual patient" model. Xception models achieve accuracy up to 90% in assessing facial symmetry. Professional systems, such as 3dMDtrio, and mobile applications demonstrate comparable accuracy (~80% of points within 1 mm).

- *Segmentation and 3D modeling of dental arches:* Automatic segmentation of teeth and roots is possible even in the presence of brackets. 3D models are used for planning aligners and orthodontic appliances. Differences in accuracy compared to manual methods are minimal (0.07–0.08 mm vs. 0.02–0.03 mm), with a significant gain in time efficiency.
- *Diagnosis of TMJ disorders:* AI detects temporomandibular joint (TMJ) dysfunctions and osteoarthritis on MRI scans. The following architectures are used: U-Net, 3DiscNet, SegNet, Xception, and Inception.
- *Prediction of treatment outcomes:* Machine learning and deep learning predict 3D facial changes and treatment duration. Mean prediction error for 3D facial modeling is 1.2 ± 1.01 mm (accuracy 80.8%). Random Forest and linear models demonstrated the highest clinical accuracy.
- *Telementoring and treatment monitoring:* AI enables remote monitoring of treatment progress and reduces the number of clinical visits. 96.25% of orthodontists consider telemonitoring a component of high-tech treatment. Algorithms analyze intermediate data and provide a quantitative assessment of treatment effectiveness in correcting anomalies.

Discussion. The obtained data indicate that the implementation of artificial intelligence in orthodontics creates a qualitatively new level of clinical practice based on big data analysis and a personalized approach to patients. Despite the high accuracy of algorithms, their effectiveness largely depends on the quality of input data, standardization of protocols, and the representativeness of training datasets.

Conclusions.

1. AI improves diagnostic accuracy, accelerates data analysis, and optimizes treatment planning.
2. Deep learning enables the development of multimodal and integrated clinical systems.
3. AI serves as an assistive tool, while the clinician retains the leading role in decision-making.
4. Further research should focus on clinical validation and improving the reliability of algorithms.

Keywords: *Artificial intelligence; machine learning; deep learning; neural networks; orthodontics; prediction; 3D modeling; telemonitoring.*