

Egyptian Prosthodontic Association (EPA Newsletter)

Artificial Intelligence in Contemporary Fixed Prosthodontics: Applications, Clinical Implications, and Limitations



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Artificial Intelligence (AI) has emerged as a transformative tool in fixed prosthodontics. This review summarizes current applications of AI in diagnosis, treatment planning, CAD/CAM systems, implantology, maxillofacial prosthodontics, and fixed restorations. AI technologies (including machine learning, deep learning, artificial neural networks, and generative models) enhance precision, efficiency, and predictive accuracy. Although AI shows significant potential in automating crown design, margin detection, shade selection, and implant planning, its integration into clinical practice requires validation, ethical oversight, and regulatory compliance. (1)

KEY APPLICATIONS

I. DIAGNOSIS

1- Diagnosis and Treatment Planning

AI systems enhance diagnostic accuracy by analyzing radiographs (panoramic radiographs, periapical radiographs, micro-computed tomography images), CBCT scans, and intraoral digital data. Artificial neural networks enable automated segmentation and predictive treatment analysis. (2)

2- Predictable Analysis

AI for prosthodontic restorations has shown that AI can predict the success rates of various treatments by analyzing large datasets of patient outcomes. (3)

II. CAD-CAM

AI integration improves chairside efficiency by automating crown morphology generation and preparation margin detection with accuracy comparable to conventional workflows. (4)

III. IMPLANTOLOGY

AI is Transforming Dental Implant Practices across several areas such as: diagnosis, treatment planning, IOS and prosthesis fabrication and prognosis. (5-8)

1- Diagnosis: AI algorithms possess the capability to analyze CBCT scans to detect the quality and quantity of bone & do automatic segmentation. Also accurately identify and classify dental pathologies, bone structures, and anatomical landmarks. This capability is crucial for the precise placement of dental implants, ensuring optimal integration with the patient's existing bone structure.



2- AI Powered Bone Density Analysis: The technology analyzes CBCT scans to provide quantitative bone density measurements (non-invasively) for pre-operative implant planning. Reading of the bone quality parameter in absolute units of measurement: g/cm^3

3- AI assisted implant planning: Fully and partially Automatic Implant Planning software are available which allow accurate and predictable planning without human errors. The time required for the AI Implant Planning is $1/3$ the time required in the manual approach. Unfortunately, only AI can assist in planning of single implants till now.

4- Implant Prosthodontics: recent IOS identifies the location of the scan body and AI automatically launches all proper information into CAD software for instant implant abutment design.

5- Implant Prognosis: the effectiveness of AI algorithms in predicting dental implant prognosis, with accuracy levels ranging from 93.8%-98% .

IV. MAXILLOFACIAL

1- Maxillofacial Prosthodontics: Primary objectives when managing patients in the field of maxillofacial prosthodontics should be to restore form, function, and aesthetics, maintain a healthy and sustainable periodontium, achieve stable temporomandibular joints and occlusion, preserve healthy teeth, ensure comfortable function, and attain optimal aesthetics. (9)

2- The Prediction of Facial Changes: The accurate prediction of facial changes and discrepancies in facial appearance in patients is essential not only for aesthetic satisfaction but also for functional outcomes. (10)

V. FIXED PROSTHESES

1-The Digital Smile Design: AI is increasingly being integrated into the domain of smile design, bringing forward numerous benefits and advancements. The AI algorithms possess the capability to meticulously analyze various aspects of facial features, including symmetry, lip line, tooth shape, and size, to generate optimal smile designs. (11)

2- The Tooth Shade Selection: In the past five years, researchers have identified AI as a crucial vector in advancing tooth shade selection (TSS) technologies. This process is pivotal for ensuring the aesthetic success of dental restorations. TSS arises inherently complex, demanding high-precision, consistent, and traditional methods, which often rely on visual matching, are subjective, and are susceptible to human error. (12)

3- The Automated Tooth Preparation: In 2024, Perceptive, a company based in Boston (MA, USA), introduced an AI-driven robotic system designed for dental procedures, including the preparation of teeth for dental crowns. This innovative robot utilizes advanced optical coherence tomography (OCT) and AI



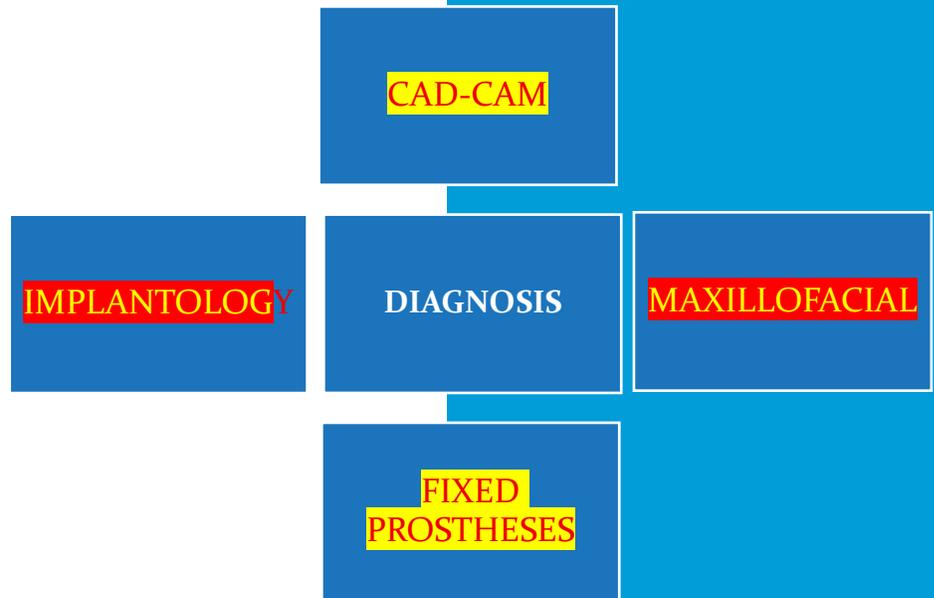
programming to create detailed 3D maps of the teeth, which are then analyzed by AI to plan the tooth preparation. The system can complete a procedure that typically takes several hours in just about 15 min. (13)

4- The Mapping of the Preparation Finishing Line: The use of AI in mapping the preparation finishing line in fixed prosthodontics promises significant precision and efficiency in the last decade. AI algorithms, particularly those based on ML and DL, have been developed to accurately detect and map the preparation finishing line of dental preparations. (14)

5- The Automated Restoration Design: are used to generate high-quality images of dental restorations. These tools primarily assist in the automated design of tooth anatomy by creating realistic representations for dental crown restorations. (15)

LIMITATIONS OF AI:

The impact of artificial intelligence on society is already significant and is expected to grow as technology improves. Like any other technology, AI has its own set of limitations and boundaries. AI technology has not been completely understood owing to its complexity, and it can autonomously change its behaviour.





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