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The Role and Applications of Artificial Intelligence in Dental Implant Planning: A systematic review

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ADMINISTRATIVE INFORMATION

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 30 July 2024 and was last updated on 30 July 2024.

INTRODUCTION

Review question / Objective This literature review aims to evaluate the current evidence on the use of AI in implant planning assessment. What are the current uses of AI in implant planning described in the literature?

Rationale Implant planning involves the evaluation of patient anatomy, bone density, and other factors to determine the optimal position, size, and angle of dental implants. Traditionally, this process has relied heavily on the expertise and experience of dental professionals, often involving manual measurements and subjective assessments.

Condition being studied The target condition involves patients with missing teeth (edentulism) who require detailed diagnostic evaluations for the planning of dental implant placement.This systematic review includes studies that utilize AI engines to evaluate 2D and 3D radiological imaging for the diagnostic assessment required for dental implant placement.Studies must focus on the evaluation of bone quality, bone dimensions, the identification of critical anatomical structures (e.g., nerves and maxillary sinus, Adjacent teeth), drilling protocols, and implant position.

METHODS

Search strategy A comprehensive literature search was conducted on PubMed, Scopus and Web of Science databases to identify relevant studies related to the role and applications of artificial intelligence (AI) in implant planning. In addition, Google Scholar was reviewed.
Further manual exploration of the reference lists of all full-text articles and relevant reviews identified from the electronic search was also conducted. Additionally, manual searches were carried out in the following journals: Journal of Prosthodontic Research, Journal of Prosthetic Dentistry, Clinical Oral Implants Research, International Journal of Oral Maxillofacial Implants, Clinical Implant Dentistry and Related Research, Implant Dentistry, and Journal of Implantology. The search was performed using a combination of keywords and

Medical Subject Headings (MeSH) terms, including: ((Artificial Intelligence [Mesh] OR (AI) OR (machine learning) OR (deep learning)) AND ((Implant Planning [Mesh] OR (implantology) OR (implant treatment plan)).

Participant or population This systematic review includes studies that utilize AI engines to evaluate 2D and 3D radiological imaging for the diagnostic assessment required for dental implant placement. patients with missing teeth (edentulism) .Thus, the population is taken from radiological databases of edentulous, partially edentulous, and single-tooth edentulous patients. Specifically, CBCT, periapical radiographs, and panoramic radiographs (OPT) will be considered."

Intervention The index tests under review are AI-based technologies and tools that assist clinicians in the planning and placement of dental implants. AI algorithms that analyze radiological images, provide 3D reconstructions, and suggest optimal implant sites while ensuring the preservation of vital anatomical structures.

Comparator Implant treatments planned without the use of artificial intelligence.

Study designs to be included Clinical trials, case reports, case series, and in vitro studies; , only articles published in English and within the period 2020-2024 were considered.

Eligibility criteria inclusion criterion was that clinical studies be based on human radiological images, excluding those of animals, obtained from the databases of dental clinics of patients undergoing oral implantology. The exclusion criteria were set to omit review articles and letters to editors, as well as animal studies, Multiple publications on the same patient population.

Information sources Database search :PubMed, Scopus, Web of Science database. Electronic Journals: Journal of Prosthodontic Research, Journal of Prosthetic Dentistry, Clinical Oral Implants Research, International Journal of Oral Maxillofacial Implants, Clinical Implant Dentistry and Related Research, Implant Dentistry, Journal of Implantology.

Main outcome(s) Applications or diagnostic performance of the proposed AI model.

Additional outcome(s) Evaluation of bone density and drilling protocols.

Quality assessment / Risk of bias analysis The quality of the included studies will be evaluated using appropriate assessment tools, specifically the Newcastle-Ottawa Scale (NOS). A star rating system will be employed to facilitate a semi-quantitative assessment of study quality. This system, based on NOS, will score studies from zero to nine stars. Studies will be classified as high-quality if they achieve seven or more stars, medium-quality if they receive between four and six stars, and poor-quality if they receive fewer than four stars.

Strategy of data synthesis The minimum number of studies or level of consistency required for synthesis is 5 studies. A statistical analysis will be performed on the number of datasets used by the studies.

Subgroup analysis The number of planned implants and the number of implants placed according to the implant planning will also be analyzed. Whether completely edentulous or partially edentulous, the position of the placed implants will also be analyzed.

Sensitivity analysis A star system was implemented to allow a semi-quantitative assessment of study quality. The NOS ranges from zero to nine stars. We classified studies as high-quality if they achieved seven or more stars, medium-quality if they received four to six stars, and poor-quality if they had fewer than four stars.

Language restriction English.

Country(ies) involved Italy, University of Bari; Italy , University of Chieti; Spain, European University of Madrid; Saudi Arabia, King Faisal University.

Keywords Artificial Intelligence in Implantology; AI in Dental Implantology; Machine Learning in Dental Implantology; Deep Learning in Implant Dentistry; Robotics in.

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