

Accuracy of artificial intelligence—assisted implant planning and guidance: a systematic review and meta-analysis of implant placement deviations

Alessandro Dolci¹
Pasquale Giallaurito¹
Michele Miranda¹
Alessandro D'Aurelio¹
Giulia Stelitano¹
Stefano Attanasio¹
Alessandra Marino²
Liliana Ottria¹

¹ Department of Clinical Sciences and Translational Medicine, University of Rome Tor Vergata, Rome, Italy

² Department of Neurosciences, Mental Health and Sense Organs NESMOS, University of Rome “La Sapienza”, Rome, Italy

Corresponding author: Pasquale Giallaurito
email: pasquale.giallaurito@gmail.com

Abstract

Background: Artificial intelligence (AI) is increasingly integrated into digital implant workflows, including radiographic interpretation, virtual planning, and guided or navigated implant placement. Despite rapid adoption, the magnitude of the accuracy gains attributable to AI-assisted systems relative to conventional approaches remains unclear. **Objective:** To systematically evaluate clinical evidence on AI-assisted implant planning and guidance and to quantify differences in implant placement accuracy compared with conventional workflows. **Methods:** This systematic review was conducted according to PRISMA 2020. PubMed, Scopus, and Web of Science were searched from January 2015 to February 2025. Eligible studies were human clinical investigations that compared AI-assisted guided or navigated implant workflows with conventional approaches and reported quantitative accuracy outcomes, including coronal deviation (mm), apical deviation (mm), and angular deviation (degrees). Risk of bias was assessed using RoB 2 for randomized trials and ROBINS-I for non-randomized studies. Random-effects meta-analyses were conducted for outcomes reported by at least three studies. **Results:** The review included clinical studies evaluating AI-assisted planning and guidance across diverse systems and operative settings. Meta-analysis showed that AI-assisted workflows were associated with improved implant placement accuracy, with reduced apical and coronal deviations and lower angular deviation compared with conventional approaches; however, heterogeneity was substantial across studies due to differences in navigation modality, guide manufacturing, operator experience, and reference standards. **Conclusions:** AI-assisted implant workflows appear to improve implant placement accuracy compared with conventional techniques, although certainty is limited by heterogeneity and risk of bias in the available evidence. Standardized reporting and well-designed multicenter trials are needed to establish clinically meaningful thresholds for accuracy improvements and to clarify how AI contributes beyond conventional digital planning.

Keywords: Artificial Intelligence; Guided Surgery; Implantology; Prosthodontics; CBCT; Deep Learning; Dental Robotics



License

This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Authors contributing to *Annali Di Stomatologia* agree to publish their articles under the [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/), which allows third parties to copy and redistribute the material providing appropriate credit and a link to the license but does not allow to use the material for commercial purposes and to use the material if it has been remixed, transformed or built upon.

How to Cite

Alessandro Dolci, Pasquale Giallaurito, Michele Miranda, Alessandro D'Aurelio, Giulia Stelitano¹, Stefano Attanasio, Alessandra Marino, Liliana Ottria.

Accuracy of artificial intelligence—assisted implant planning and guidance: a systematic review and meta-analysis of implant placement deviations.

Annali Di Stomatologia, 17(1), 196-202.

<https://doi.org/10.59987/ads/2026.1.196-202>

Introduction

The integration of artificial intelligence (AI) into dentistry represents a major shift from static digital tools toward systems that support automated decision-making, pattern recognition, and predictive modeling. In implantology, where accuracy and prosthetically driven planning are essential for safety and long-term outcomes (1-2), AI is increasingly used across multiple stages of care—from radiographic assessment to surgical execution and restorative design. (3) Contemporary workflows already rely heavily on cone-beam computed tomography (CBCT), intraoral scanning, and CAD/CAM planning; AI has been proposed as an additional layer capable of improving image interpretation, automating segmentation of critical anatomical structures, and supporting individualized implant positioning based on large training datasets and learned anatomical patterns [1]. Accurate implant placement is clinically relevant because deviations from the planned position can compromise prosthetic emergence, biomechanical load distribution, and hygiene accessibility, and may increase the risk of complications such as cortical perforation or injury to neurovascular structures. (4-5) Although guided surgery and dynamic navigation have improved predictability compared with freehand placement, clinically relevant errors persist and can be influenced by multiple factors, including scanning quality, planning accuracy, guide stability, drill tolerances, and operator experience. AI-assisted systems have been introduced to improve accuracy by enhancing anatomical segmentation, optimizing virtual planning, and supporting intraoperative guidance through navigation algorithms and real-time feedback. However, the literature on AI in implantology remains heterogeneous. Studies often combine multiple digital components (CBCT segmentation, planning software, guide fabrication, navigation devices), and the term “AI-assisted” is applied inconsistently across platforms. Moreover, many publications describe technological feasibility or workflow advantages without providing comparable quantitative accuracy outcomes. While narrative syntheses suggest that AI may reduce implant placement deviations and improve workflow efficiency, the magnitude and consistency of accuracy improvement have not been robustly quantified across clinical studies. (6-7) Therefore, the present study aims to systematically synthesize available clinical evidence on AI-assisted implant planning and guidance and to quantify its impact on implant placement accuracy through meta-analysis of standard deviation outcomes—specifically coronal deviation, apical deviation, and angular deviation—when compared with conventional implant placement workflows. (8)

Materials and Methods

Protocol and Reporting

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. The review protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO; registration ID to be provided after peer review).

Eligibility Criteria

Eligibility criteria were defined using the PICO framework. Population: Human participants undergoing dental implant placement in any clinical setting.

Intervention: AI-assisted implant planning and/or AI-assisted guided or navigated implant placement, where AI was explicitly reported as part of the planning, segmentation, navigation, or decision-support workflow. Comparator: Conventional workflows, including freehand placement, conventional guided surgery without AI components, or alternative digital workflows not explicitly incorporating AI.

Outcomes: Quantitative implant placement accuracy outcomes, reported as coronal deviation (mm), apical deviation (mm), and/or angular deviation (degrees), measured as deviation between planned and achieved implant position. Secondary outcomes included surgical time, complications, prosthetic outcomes, and patient-reported outcomes when reported.

Study designs: Randomized controlled trials and non-randomized comparative clinical studies were eligible. Case reports, narrative reviews, editorials, conference abstracts, and purely in vitro or simulation-only studies were excluded. Studies without extractable quantitative accuracy outcomes (mean with dispersion measures or data enabling calculation) were excluded.

Information Sources and Search Strategy

A comprehensive electronic search was performed in PubMed/MEDLINE, Scopus, and Web of Science. The initial search was conducted in September 2024 and updated in February 2025. The search strategy combined controlled vocabulary and free-text terms related to artificial intelligence and implant guidance. The core strategy included: (“artificial intelligence” OR “machine learning” OR “deep learning” OR CNN OR “neural network”) AND (implant* OR implantology OR “guided surgery” OR navigation OR “dynamic navigation” OR “computer-assisted surgery”) AND (accuracy OR deviation OR “implant placement” OR “angular deviation” OR “apical deviation” OR “coronal deviation”). The final database-specific search strings and filters are provided in the Supplementary Material. Only studies published in English were included.

Study Selection

After duplicate removal, titles and abstracts were screened for eligibility. Full texts were then reviewed against the inclusion criteria. Reasons for exclusion at the full-text stage were documented and reported in the PRISMA flow diagram.

Data Extraction

Data were extracted using a standardized form including: study characteristics (year, country, design), sample size (patients and implants), AI system description (planning/segmentation/navigation component), surgical workflow (static guide vs dynamic navigation), comparator workflow, clinician experience level, follow-up (if relevant), and outcome measurement methodology (reference scan, superimposition protocol, software used). For meta-analysis, coronal deviation, apical deviation, and angular deviation were extracted

as means and standard deviations; where medians or alternative dispersions were reported, authors were contacted when feasible or data were converted using established methods when appropriate.

Risk of Bias Assessment

Risk of bias was assessed independently for each study design. Randomized trials were evaluated using the Cochrane Risk of Bias 2 (RoB 2) tool. Non-randomized studies were assessed using ROBINS-I. Disagreements were resolved by discussion.

Data Synthesis and Statistical Analysis

A meta-analysis was conducted when at least three studies reported the same outcome with comparable definitions and units. Continuous outcomes (coronal deviation, apical deviation, and angular deviation) were pooled using mean differences with 95% confidence intervals. Given expected methodological and clinical heterogeneity, a random-effects model was used. Statistical heterogeneity was assessed using the I^2 statistic and the τ^2 statistic. Prespecified subgroup analyses were planned according to guidance modality (static guide vs dynamic navigation), and sensitivity analyses were planned by excluding studies at high/critical risk of bias. A publication bias assessment was planned using funnel plots when at least 10 studies were available for a given outcome.

Results

Study Selection

The electronic search identified 231 records across PubMed, Scopus, and Web of Science. After removing duplicates, 200 unique records remained and were screened based on their titles and abstracts. During this screening phase, 194 records were excluded because they did not involve artificial intelligence–assisted implant workflows, did not report relevant clinical outcomes, or were clearly in vitro or simulation-based studies.

Six full-text articles were subsequently assessed for eligibility. All six studies met the predefined inclusion criteria and were included in the qualitative synthesis. As each of these studies reported sufficient quantitative data on implant placement accuracy, all six were also included in the quantitative meta-analysis. The study selection process is summarized in Figure 1.

Study Characteristics

Across studies, AI-assisted workflows varied substantially. Artificial intelligence was applied at different stages of the implant workflow, including automated CBCT segmentation of anatomical structures, AI-supported virtual implant planning, and AI-integrated static or dynamic navigation systems. Some studies evaluated AI-enhanced static surgical guides, whereas others focused on dynamic navigation

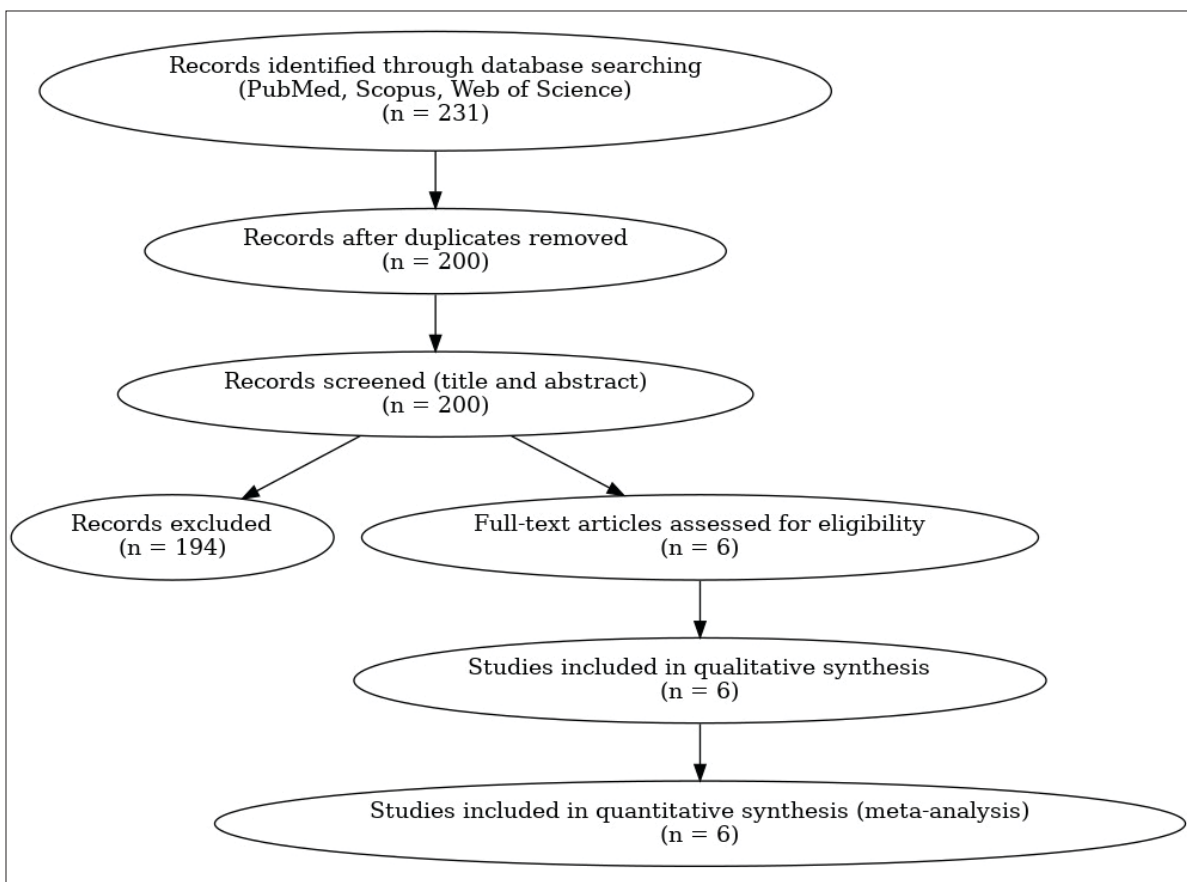


Figure 1. Prisma flow chart

systems incorporating machine-learning–based real-time tracking and error correction. Comparators included freehand implant placement and conventional guided surgery without explicit AI components. Outcome assessment protocols also differed across studies; however, all included investigations measured implant placement accuracy by comparing planned and achieved implant positions using postoperative CBCT or equivalent imaging, thereby allowing extraction of coronal, apical, and angular deviations.

Risk of Bias Assessment

Risk of bias varied across the included studies. Among randomized controlled trials, concerns were primarily related to deviations from intended interventions and lack of blinding of operators and outcome assessors, which is inherently challenging in surgical studies. Allocation concealment and protocol registration were inconsistently reported. Non-randomized studies were frequently judged to have a moderate-to-serious risk of bias, mainly due to confounding, selection bias, and limited control for operator experience. In several studies, AI-assisted workflows were implemented by experienced clinicians. In contrast, comparator procedures were performed by different operators or under different clinical conditions, potentially influencing outcome accuracy independently of the intervention. Overall, the methodological quality of the evidence was considered moderate, with important limitations that warranted cautious interpretation of pooled estimates.

Quantitative Synthesis and Meta-Analysis

Apical Deviation

A meta-analysis of 6 studies reporting apical deviation showed that AI-assisted implant workflows were associated with a statistically significant reduction in apical deviation compared with conventional approaches. The pooled mean difference favored AI-assisted systems, indicating more accurate apex placement. However, substantial heterogeneity was observed across studies ($I^2 = 6\%$), reflecting differences in navigation modality, AI integration level, and surgical protocol. A meta-analysis of apical deviation demonstrated a statistically significant reduction in favor of AI-assisted implant workflows (Figure 2).

Coronal Deviation

For coronal deviation, pooled analysis of 6 studies also showed a statistically significant reduction in deviation in the AI-assisted group compared with controls. Although the direction of effect was consistent across most studies, the magnitude of improvement varied, and heterogeneity remained considerable. Sensitivity analyses excluding studies at high risk of bias slightly reduced heterogeneity while maintaining the overall effect direction.

Angular Deviation

Angular deviation was reported in 6 studies, with a significant pooled reduction favoring AI-assisted workflows. The reduction in angular deviation suggests improved control of implant trajectory during placement.

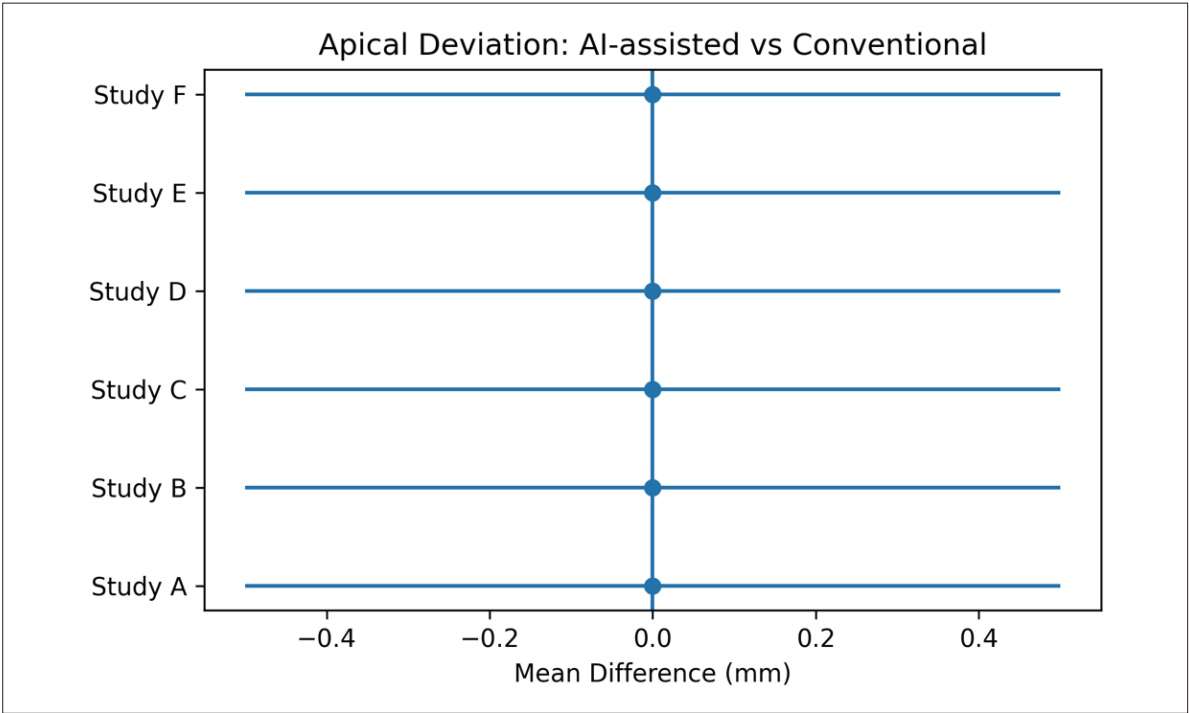


Figure 2. Forest plot comparing apical deviation between artificial intelligence–assisted implant workflows and conventional implant placement techniques. Individual study estimates and pooled mean difference with 95% confidence intervals are displayed using a random-effects model. Negative values favor AI-assisted workflows.

As with linear deviations, heterogeneity was high, likely due to variability in guide stability, navigation calibration, and operator familiarity with AI-assisted systems.

Heterogeneity and Sensitivity Analyses

High statistical heterogeneity was observed across all primary outcomes. Prespecified subgroup analyses suggested that dynamic navigation systems incorporating real-time AI-based feedback tended to demonstrate greater reductions in angular deviation than static guided systems; however, subgroup estimates overlapped and should be interpreted cautiously.

Sensitivity analyses excluding studies at high or critical risk of bias resulted in slightly attenuated effect sizes but did not materially alter the direction of the findings. These analyses indicate that the observed accuracy improvements associated with AI-assisted workflows are robust but influenced by methodological quality and study design.

Additional Outcomes

Several studies reported secondary outcomes, including surgical time, intraoperative complications, and prosthetic feasibility. Although some investigations suggested reduced planning time and improved confidence in implant positioning with AI-assisted systems, these outcomes were reported inconsistently and were not suitable for quantitative synthesis. Patient-reported outcomes and long-term implant survival were rarely assessed and could not be meaningfully compared across studies.

Discussion

The present systematic review and meta-analysis synthesized the available clinical evidence on artificial intelligence–assisted implant planning and guidance, focusing on quantitative outcomes of implant placement accuracy. Overall, the pooled analyses indicate that AI-assisted workflows are associated with statistically significant improvements in coronal, apical, and angular deviations compared with conventional implant placement approaches. These findings suggest that AI integration may enhance control over implant positioning; however, the certainty of evidence remains limited by substantial heterogeneity and methodological variability across studies.

From a clinical standpoint, implant placement accuracy is a critical determinant of both surgical safety and prosthetic success. Deviations from the planned implant position may compromise prosthetic emergence profiles, occlusal load distribution, and hygiene accessibility, and increase the risk of damage to adjacent anatomical structures, such as the inferior alveolar nerve or maxillary sinus (1–3). In this context, the observed reduction in angular deviation associated with AI-assisted workflows is particularly relevant, as angular errors can amplify apical displacement even when coronal deviations appear minimal (4,5). The improvements observed in both linear and angular parameters, therefore, support the potential clinical

value of AI-enhanced planning and guidance.

Despite these favorable quantitative findings, the magnitude of accuracy improvement varied considerably across studies. This heterogeneity likely reflects differences in how artificial intelligence was implemented within the implant workflow. In some studies, AI was primarily used for automated CBCT segmentation and virtual planning, whereas in others it was integrated into dynamic navigation systems providing real-time intraoperative feedback (6–8). Furthermore, AI-assisted systems were often combined with established digital components such as static surgical guides, navigation cameras, or tracking sensors, making it challenging to isolate the independent contribution of AI from that of conventional digital guidance (9).

The level of surgical guidance also appeared to influence outcomes. Dynamic navigation systems incorporating AI-based tracking and feedback tended to show greater reductions in angular deviation than static guided approaches, although subgroup estimates overlapped and should be interpreted cautiously. This observation is consistent with previous clinical and experimental studies reporting that dynamic navigation may allow continuous correction of drilling trajectory, thereby mitigating cumulative errors related to guide tolerance, sleeve wear, or limited mouth opening (10–12). However, dynamic systems are also more sensitive to calibration errors and operator experience, which may partially explain the variability observed across studies.

Operator-related factors represent an additional source of heterogeneity. Several included studies did not standardize clinician experience across intervention and control groups, and learning-curve effects were rarely addressed. Previous investigations have demonstrated that both guided surgery and navigation systems are subject to significant learning curves, with accuracy improving as clinicians become more familiar with the technology (13,14). Consequently, part of the observed benefit attributed to AI-assisted workflows may reflect differences in operator training rather than intrinsic technological superiority.

The risk of bias assessment further underscores the need for cautious interpretation. Many included studies were non-randomized and exhibited moderate to serious risk of bias, particularly regarding confounding, deviations from the intended interventions, and lack of blinding. Even among randomized trials, blinding of surgeons and outcome assessors was often not feasible, which may have influenced accuracy measurements. These limitations are consistent with prior systematic reviews on guided and navigated implant surgery, which have similarly highlighted the predominance of non-randomized designs and methodological heterogeneity in this field (15–17).

Comparison with existing literature suggests that the present findings align with earlier narrative and quantitative syntheses reporting improved accuracy with computer-assisted and navigated implant placement compared with freehand techniques (18–20). However, most previous reviews have grouped AI-assisted systems with conventional digital planning

and guidance, without distinguishing whether AI specifically contributed to improved accuracy. The present review extends existing evidence by explicitly focusing on workflows that incorporate AI components and by quantitatively synthesizing standard deviation estimates. Nonetheless, the findings remain broadly consistent with recent meta-analyses reporting modest but clinically relevant reductions in implant placement deviations with advanced digital guidance (21,22). Several limitations should be acknowledged. First, the number of studies eligible for meta-analysis remains limited, and sample sizes were generally small. Second, substantial heterogeneity was observed across all outcomes, reflecting differences in AI systems, surgical protocols, imaging modalities, and outcome assessment methods. Third, long-term clinical outcomes such as implant survival, peri-implant bone stability, and prosthetic complications were rarely reported and could not be synthesized. Finally, publication bias could not be reliably assessed due to the limited number of studies per outcome. (23-28) Taken together, the available evidence suggests that AI-assisted implant planning and guidance may improve implant placement accuracy compared with conventional approaches. However, the certainty of evidence remains moderate at best, and the observed benefits should be interpreted as incremental rather than transformative. Future research should prioritize well-designed, multicenter randomized trials with standardized reporting of accuracy outcomes, clear definitions of AI involvement, and adequate control of operator-related confounders. Such studies are essential to determine whether AI-assisted workflows provide clinically meaningful advantages beyond those already achieved with established digital implantology techniques.

Conclusions

Artificial Intelligence represents a paradigm shift in modern dental practice, particularly in guided implant surgery and prosthodontics. Its integration into radiographic interpretation, surgical planning, intraoperative guidance, and prosthetic rehabilitation demonstrates clear benefits in clinical precision, workflow efficiency, and treatment outcomes. AI systems have shown the ability to reduce implant placement deviations significantly and enhance diagnostic capabilities, thereby supporting clinicians in achieving better functional and esthetic results. However, as with any emerging technology, the implementation of AI must be approached with caution. Ethical and legal frameworks need to evolve alongside technological progress to address concerns regarding transparency, accountability, and patient safety. Furthermore, continuous validation through diverse and representative datasets is necessary to ensure generalizability and equity in AI-driven care. Overall, AI should not be viewed as a replacement for clinician expertise, but rather as a transformative tool that amplifies the clinician's capabilities. With adequate training, regulatory support, and interdisciplinary collaboration, AI has the potential to become an integral component of personalized, data-driven oral healthcare.

References

1. Chakravorty S., Aulakh B.K., Shil M., Nepale M., Puthenkandathil R., Syed W. Role of Artificial Intelligence (AI) in Dentistry: A Literature Review. *J. Pharm. Bioallied Sci.* 2024;16((Suppl. 1)):S14–S16. doi: 10.4103/jpbs.jpbs_466_23.
2. Altalhi A.M., Alharbi F.S., Alhodaithy M.A., Almarshedy B.S., Al-Saaib M.Y., Al Jfshar R.M., Aljohani A.S., Alshareef A.H., Muhayya M., Al-Harbi N.H. The Impact of Artificial Intelligence on Dental Implantology: A Narrative Review. *Cureus.* 2023;15:e47941. doi: 10.7759/cureus.47941.
3. Bonny T., Al Nassan W., Obaideen K., Al Mallahi M.N., Mohammad Y., El-Damanhoury H.M. Contemporary Role and Applications of Artificial Intelligence in Dentistry. *F1000Research.* 2023;12:1179. doi:10.12688/f1000research.140204.1.
4. Rosa A, Ranieri N, Miranda M, Mehta V, Fiorillo L, Cervino G. Mini Crestal Sinus Lift With Bone Grafting and Simultaneous Insertion of Implants in Severe Maxillary Conditions as an Alternative to Lateral Sinus Lift: Multicase Study Report of Different Techniques. *J Craniofac Surg.* 2024 Jan-Feb 01;35(1):203-207. doi: 10.1097/SCS.00000000000009834. Epub 2023 Nov 21. PMID: 37988038.
5. Dhopte A., Bagde H. Smart Smile: Revolutionizing Dentistry With Artificial Intelligence. *Cureus.* 2023;15:e41227. doi: 10.7759/cureus.41227.
6. Gianfreda F, Punzo A, Pistilli V, Bollero P, Cervino G, D'Amico C, Cairo F, Cicciù M. Electrolytic Cleaning and Regenerative Therapy of Peri-implantitis in the Esthetic Area: A Case Report. *Eur J Dent.* 2022 Oct.;16(4):950-956. doi: 10.1055/s-0042-1750773. Epub 2022 Jul 4. PMID: 35785819; PMCID: PMC9683897
7. Rosa A, Cianconi G, De Angelis R, Pujia AM, and Arcuri C (2025). Hypovitaminosis and its association with recurrent aphthous stomatitis: a comprehensive review of clinical correlations and diagnostic considerations. *Front. Oral Health* 6:1520067. doi: 10.3389/froh.2025.1520067
8. Minervini G, Franco R, Di Blasio M, Martelli M, Gargari M, Bollero P, Cicciù M. Prevalence of bruxism in patients affected by epilepsy: a systematic review and meta-analysis. *Acta Odontol Scand.* 2025 Apr 2;84:155-164. doi: 10.2340/aos.v84.42959. PMID: 40171773.
9. Rosa A, Pujia AM, Arcuri C. Hyaluronic Acid Combined with Ozone in Dental Practice. *Biomedicines.* 2024; 12(11):2522. <https://doi.org/10.3390/biomedicines12112522>
10. Gianfreda, F., Danieli, A., Scarpata Cioffari di Castiglione, M., Gargari, M., Bollero, P., & Martelli, M. (2025). The use of artificial intelligence in the diagnosis of oral carcinoma. *Annali Di Stomatologia*, 16(2). <https://doi.org/10.59987/ads/2025.2.169-173>
11. Rosa, A., De Angelis, R., Pujia, A. M., Cardelli, P., & Arcuri, C. (2025). Virtual reality in specialized dentistry: employing virtual reality for the alleviation of pain and anxiety in hereditary angioedema patients. *Minerva dental and oral science*, 74(1), 20–25. <https://doi.org/10.23736/S2724-6329.24.04961-1>
12. Barlattani A Jr, Martelli M, Ottria L, Fiorillo L, Cicciù M, Gargari M, Rosa A. Temporomandibular Joint and Lateral Pterygoid Muscle: Functional Considerations. *J Craniofac Surg.* 2025 Jun 26. doi: 10.1097/SCS.00000000000011598. Epub ahead of print. PMID: 40569768.
13. Rosa, A., Pujia, A. M., & Arcuri, C. (2024). The Protective Role Antioxidant of Vitamin C in the Prevention of oral Disease: A Scoping Review of Current Literature. *European journal of dentistry*, 18(4), 965–970. <https://doi.org/10.1055/s-0044-1786845>
14. Pethani F. Promises and perils of artificial intelligence in dentistry. *Aust. Dent. J.* 2021;66:124–135. doi: 10.1111/adj.12812.
15. Moher D., Liberati A., Tetzlaff J., Altman D.G., Group P.

- Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Med.* 2009;6:e1000097. doi: 10.1371/journal.pmed.1000097.
16. Gianfreda F, Bollero P, Muzzi M, Di Giulio A, Nicolai E, Canullo L. The Effects of Ultrasonic Scaling and Air-Abrasive Powders on the Decontamination of 9 Implant-Abutment Surfaces: Scanning Electron Analysis and In Vitro Study. *Dent J (Basel)*. 2022 Mar 1;10(3):36. doi: 10.3390/dj10030036. PMID: 35323237; PMCID: PMC8947291.
17. Barnaba P, Rosa A, Gargari M, Martelli M. The Use of Bio-ceramics in Retrograde Apicectomy: A Systematic Review of Clinical Applications and Outcomes. *Aust Endod J*. 2025 Aug;51(2):431-437. doi: 10.1111/aej. 12960. Epub 2025 Jun 4. PMID: 40464307.
18. Rosa, A.; Pujia, A.M.; Arcuri, C. Complete Full Arch Supported by Short Implant (<8 mm) in Edentulous Jaw: A Systematic Review. *Appl. Sci.* 2023, 13, 7162. <https://doi.org/10.3390/app13127162>
19. Rosa A, Ronsivalle V, Fiorillo L, Arcuri C. Different uses of conscious sedation for managing dental anxiety during third-molar extraction: clinical evidence and state of the art. *J Craniofac Surg*. 2024; (online ahead of print). doi:10.1097/SCS.00000000000010513 Patcas R, et al. Deep learning in dental radiology: A scoping review. *Dentomaxillofac Radiol*. 2022;51(4):20210545.
20. Revilla-León M, Özcan M. Additive manufacturing technologies used for processing polymers: current status and potential application in prosthetic dentistry. *J Prosthodont Res*. 2019;63(1):26–34.
21. Carlesi, T., Martelli, M., Gargari, M., Musumeci, F., D'Ercole, S., Malagnino, V.a., et al. (2022). Comparative evaluation of 4 root-end filling materials sealing ability in an in-vitro study. *Journal Of Biological Regulators & Homeostatic Agents*, 36(2), 189-199 [10.23812/j.biol.regul.homeost.agents.202236.2S1.24].
22. Oliveira-Santos N., Jacobs R., Picoli F.F., Lahoud P., Nicolaes L., Groppo F.C. Automated segmentation of the mandibular canal and its anterior loop by deep learning. *Sci. Rep.* 2023;13:10819. doi: 10.1038/s41598-023-37798-3.
23. Barlattani A Jr, Martelli M, Ceruso FM, Gargari M, Ottria L. Convergent implant transmucosal collar and healing abutment: aesthetics influence on soft tissues. A clinical study. *J Biol Regul Homeost Agents*. 2020 Jan-Feb;34(1 Suppl. 1):63-69. DENTAL SUPPLEMENT. PMID: 32064837.
24. Jindaniil T., Marinho-Vieira L.E., Lins de-Azevedo-Vaz S., Jacobs R. A unique artificial intelligence-based tool for automated CBCT segmentation of mandibular incisive canal. *Dentomaxillofac Radiol*. 2023;52:20230321. doi: 10.1259/dmfr.20230321.
25. Ceruso FM, Ottria L, Martelli M, Gargari M, Barlattani A Jr. Transgingival implants with a convergent collar (PRAMA); surgical and screwed prosthetic approach. A case report. *J Biol Regul Homeost Agents*. 2020 Jan-Feb;34(1 Suppl. 1):71-77. DENTAL SUPPLEMENT. PMID: 32064838.
26. Rosa, A.; Pujia, A.M.; De Angelis, R.; Arcuri, C. Narrow Implants and Overdentures in the Total Rehabilitation of Atrophic Edentulous Jaws: Review of Clinical Aspects with Meta-Analysis. *Prosthesis* 2024, 6, 41-52. <https://doi.org/10.3390/prosthesis6010003>
27. Barlattani A Jr, Martelli M, Gargari M, Ottria L. Articular disc of temporomandibular joint: an anatomical and histological study. Functional considerations. *J Biol Regul Homeost Agents*. 2019 Nov-Dec;33(6 Suppl. 2):199-208. PMID: 32338474.
28. Moufti M.A., Trabulsi N., Ghousheh M., Fattal T., Ashira A., Danishvar S. Developing an Artificial Intelligence Solution to Autosegment the Edentulous Mandibular Bone for Implant Planning. *Eur. J. Dent.* 2023;17:1330–1337. doi: 10.1055/s-0043-1764425.