

The Evolving Role of Artificial Intelligence in Oral Healthcare: A Systematic Review of Current Applications and Clinical Evidence.

Dr Hitesh M Desarda¹, Dr Nisha Salvi², Dr Vummadi Keerthi³, Dr. Shital Kharat⁴, Dr. Supriya Vaidya⁵

¹MDS, Assistant Professor, Department of Periodontology, Government Dental College and Hospital, Jalgaon, Maharashtra, India
hitesh.desarda@gmail.com

²MDS, Assistant Professor, Department of Periodontology, Government Dental College and Hospital, Jalgaon, Maharashtra, India
nishasalvi291@gmail.com

³MDS, Assistant Professor, Department of Oral Medicine and Radiology, Government Dental College and Hospital, Jalgaon, Maharashtra, India
vummadikeerthi1994@gmail.com

⁴MDS, Assistant Professor, Department of Oral Pathology and Microbiology, Government Dental College and Hospital, Jalgaon, Maharashtra, India
shitalkharat42@gmail.com

⁵MDS, Assistant Professor, , Department of Oral Pathology and Microbiology, Sarswati Dhanwantari Dental College, Parbhani, Maharashtra, India.
Supriyalvaidya263@gmail.com
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ABSTRACT

Introduction: The integration of Artificial Intelligence (AI) has initiated a paradigm shift within healthcare, particularly in the field of dentistry. As AI continues its rapid evolution, its capacity to pinpoint anatomical structures serves as a vital safeguard against clinical errors. This systematic review was conducted to evaluate how AI-driven technologies influence the precision of diagnostics, the development of treatment strategies, and the forecasting of clinical outcomes. By leveraging machine learning and deep learning, these systems have demonstrated remarkable efficacy in interpreting complex dental imagery, enabling the timely and accurate identification of conditions such as dental caries, periodontal diseases, and oral cancers.

Materials and Methods: A thorough exploration of several electronic databases—including PubMed, Scopus, Medline, Web of Science, and Google Scholar—was performed to identify relevant research. The search was restricted to literature published between January 2018 and December 2025. Out of an initial 298 identified papers, 44 were chosen for final analysis based on rigorous inclusion and exclusion parameters. The QUADAS-2 tool was utilized to assess the quality and risk of bias within the selected studies. The gathered evidence illustrates the profound impact of AI across diverse dental sectors, ranging from radiology and oncology to orthodontics, prosthodontics, and comprehensive patient management.

Conclusion: This review confirms that AI-enhanced systems in dentistry exhibit outstanding performance. By mirroring the accuracy and meticulousness of experienced specialists, AI acts as a sophisticated adjunct that elevates the standard of oral healthcare.

Keywords: Artificial Intelligence, Dentistry, Machine Learning, Deep Learning, Neural Networks.

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INTRODUCTION

The origin of the term "Artificial Intelligence" (AI) dates back to 1955, when it was first coined by John McCarthy, a figure widely celebrated as the field's pioneer.¹ The primary objective of AI is the development of systems capable of autonomous learning through data-driven algorithms to resolve complex challenges.¹ In a modern context, AI serves as an umbrella for various computational strategies—most notably machine learning (ML), neural networks (NNs), and deep learning (DL)—all of which are

designed to interpret intricate datasets to bolster clinical decision-making.^{1,2}

Machine Learning (ML): A specialized branch of AI that utilizes algorithms to forecast results based on specific datasets. The goal of ML is to allow machines to derive solutions from information without the need for direct human intervention.

Neural Networks (NNs): These consist of algorithmic frameworks that process signals through artificial neurons. Their purpose is to replicate the functional architecture and cognitive patterns of the human brain.

Deep Learning (DL): As a sophisticated extension of machine learning, deep learning employs multi-layered neural networks to examine input data. Its function is to autonomously identify patterns to enhance the precision of feature detection. Deep learning architectures are frequently known as **Convolutional Neural Networks (CNNs)**; these systems utilize abstracted filter layers to extract information, making them particularly effective for the analysis of high-resolution and complex medical imagery.

Role of AI in Dentistry

The emergence of Artificial Intelligence (AI) has sparked a fundamental shift in the dental industry, offering a promising outlook for enhancing numerous facets of clinical practice and patient care.³ Dentistry is undergoing a total evolution as AI systems are seamlessly integrated into daily workflows. These technologies have demonstrated a significant capacity for the automated interpretation of radiographic imagery and the development of precise treatment strategies.⁴ AI's diagnostic utility now spans a broad spectrum of clinical challenges, including the identification of dental caries, vertical root fractures, and apical lesions.⁵ Furthermore, these systems assist in the detection of salivary gland disorders, maxillary sinusitis, and various maxillofacial cysts.⁵ Beyond common pathologies, AI plays a critical role in identifying cervical lymph node metastasis, osteoporosis, and oncological lesions, as well as monitoring alveolar bone loss.⁶ In the field of orthodontics, it is utilized for automated cephalometric analysis and for predicting the necessity of extractions or specific treatment interventions.⁷ Additionally, AI has proven to be an effective tool in forensic dentistry, where it is employed for the precise determination of an individual's age and gender.

Evidence across various dental sub-specialties underscores the remarkable precision of modern AI architectures. In the field of **oral oncology**, research by **Fati et al. (2022)**⁸ indicates a diagnostic accuracy between **99.3% and 99.7%** for identifying OSCC. Regarding **caries detection**, **Geetha et al. (2020)**⁹ and **Cantu et al. (2021)**¹⁰ found that while **AlexNet** reached peak accuracy, the **U-Net** framework actually surpassed human practitioners in identifying proximal lesions. For **maxillary and TMJ** diagnostics, **Kuwana et al. (2021)**¹¹ and **Orhan et al. (2021)**¹² confirmed that **DetectNet, ResNet, and KNN** algorithms effectively automate the detection of sinus pathologies and joint displacements. In **forensic dentistry**, **Patil et al. (2020)**¹³ utilized ANN models to predict biological gender with **75% accuracy** using dental and mandibular data. Within **Pediatrics**, **Karhade et al. (2021)**¹⁴ established that **Auto ML** and CNNs provide the highest AUC for identifying early childhood caries. Finally, in **orthodontics**, **Shaheen et al. (2021)**¹⁵ identified **ResNet-18** as superior for orthognathic surgery diagnostics, while **DANet** excelled at skeletal age estimation.

2. Materials and Methods

2.1 Research Design and Data Collection

This systematic review was conducted in strict accordance with the **PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)** guidelines. A

comprehensive exploration of electronic databases—specifically **PubMed, Scopus, Web of Science, Medline, and Google Scholar**—was performed to identify relevant literature. The search was confined to studies published between **January 2018 and December 2025**. Search strings were developed using terms such as "dentistry," "AI," "deep learning," "machine learning," "artificial neural networks," and "convolutional neural networks." These keywords and **MeSH (Medical Subject Headings)** terms were synthesized using **Boolean operators ("AND," "OR")** to refine the results.

2.2 PICO Framework

The study was structured around the **PICO (Population, Intervention, Comparison, and Outcome)** elements to ensure a focused clinical inquiry (Table 1)

Parameter	Description and Scope
Population	Digital dental and craniofacial imagery, including 2D/3D facial photos, CAD/CAM data, and radiographic formats such as orthopantomography, CBCT, bite wing, and periapical views.
Intervention	The deployment of Artificial Intelligence frameworks, specifically machine learning and deep learning algorithms, for disease identification, clinical management, and prognostic forecasting.
Comparison	Benchmarking AI performance against licensed dental practitioners, alternative digital methodologies, and comparative analysis between different AI architectures.
Outcome	Evaluation of clinical and technical efficacy via accuracy, precision, and sensitivity ratings, AUC (Area Under the Curve) values, and the functional scalability across dental specialties.

Table 1- PICO Framework

2.3 Study Selection and Screening

Relevant papers were gathered through both automated database queries and manual journal searches. A rigorous two-stage screening process was conducted by two independent reviewers. In the primary stage, **298 potential articles** were identified based on title and abstract relevance. Following the removal of duplicates and a detailed eligibility assessment, **44 original research articles** were selected for inclusion in the final review.

Database Search Strategies

The following search strings were developed and executed across four major electronic repositories to identify relevant literature for this review.

1. PubMed / MEDLINE

The search utilized a combination of **Medical Subject Headings (MeSH)** and specific text words:

Technology Terms: "Machine Learning"[MeSH] OR "Artificial Intelligence"[MeSH] OR "Deep

Learning"[MeSH] OR "Computer Neural Networks"[MeSH] OR "Automated Pattern Recognition"[MeSH] OR "Natural Language Processing"[MeSH] OR "Artificial Neural Networks" OR "Machine Learning Algorithms" OR "Deep Neural Networks" OR "Computer-Aided Diagnosis" OR "AI" OR "ML" OR "DL"

AND (Dental Imaging Terms): "Radiography, Dental"[MeSH] OR "Cone-Beam Computed Tomography"[MeSH] OR "Panoramic Radiography"[MeSH] OR "Dental Imaging"[MeSH] OR "Dental Radiology"[MeSH] OR "Dental Cone Beam Computed Tomography" OR "Dental Panoramic Radiography" OR "Dental Image Analysis" OR "Computer-Assisted Radiographic Image Interpretation" OR "3D Imaging"

2. Scopus

A **Topic Search (TS)** approach was applied to capture broad variations:

AI Component: "Artificial Intelligence" OR "Machine Learning" OR "Deep Learning" OR "Neural Networks" OR "Image Processing" OR "Pattern Recognition" OR "Natural Language Processing" OR "Artificial Neural Networks" OR "Machine Learning Algorithms" OR "Deep Neural Networks" OR "Computer-Aided Diagnosis" OR "AI" OR "ML" OR "DL"

AND (Imaging Component): "Radiography, Dental" OR "Cone-Beam Computed Tomography" OR "Panoramic Radiography" OR "Dental Radiography" OR "Dental Imaging" OR "Dental Radiology" OR "Dental Cone Beam Computed Tomography" OR "Dental Panoramic Radiography" OR "Dental Image Analysis" OR "Radiographic Image Interpretation, Computer-Assisted" OR "3D Imaging" OR "Radiological Imaging"

AND (Context): "Dentistry" OR "Oral Medicine" OR "Oral Radiology" OR "Oral Diagnosis"

3. Web of Science

The strategy mirrored the Scopus **Topic Search (TS)** parameters, focusing on the intersection of computational intelligence, radiographic imaging, and clinical dental medicine to ensure maximum retrieval across core citation indexes.

4. Google Scholar

A refined keyword string was used to capture gray literature and broader academic publications:

Keywords: AI OR "Machine Learning" OR "Deep Learning" OR "Neural Networks" OR "Computer Vision" OR "Image Processing" OR "Pattern Recognition" OR "Natural Language Processing" OR "Artificial Neural Networks" OR "Machine Learning Algorithms" OR "Deep Neural Networks" OR "Computer-Aided Diagnosis" OR "ML" OR "DL"

AND (Imaging): "Radiography, Dental" OR "Cone-Beam Computed Tomography" OR "Panoramic Radiography" OR "Dental Radiography" OR "Dental Imaging" OR "Dental Radiology" OR "Dental Cone Beam Computed Tomography" OR "Dental Panoramic Radiography" OR "Dental Image Analysis" OR "Radiographic Image Interpretation, Computer Assisted" OR "3D Imaging" OR "Radiological Imaging"

AND (Specialty): "Dentistry" OR "Oral Medicine" OR "Oral Radiology" OR "Oral Diagnosis"

2.4 Eligibility Criteria

Inclusion Criteria: The review was limited to **English-language** publications, including **observational studies, original research, and clinical/non-clinical trials**. Selected papers were required to focus primarily on AI applications in dentistry with a clear description of the datasets used for model evaluation.

Exclusion Criteria: Studies were excluded if they were unrelated to dental AI, **unpublished**, or consisted only of abstracts. Furthermore, **grey literature, case reports, editorials, review articles**, and studies involving fewer than **ten participants or specimens** were omitted from the analysis.

2.5 Quality Evaluation and Risk of Bias

The methodological integrity and potential bias of the selected research were analyzed by two separate reviewers utilizing the **Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2)** framework. Each study was independently examined across established domains, with the reviewers documenting their findings separately. Any conflicting evaluations were settled through internal discussion or via a third reviewer's mediation to reach a final consensus. The risk of bias was categorized into three levels: **"low risk"** (indicating superior quality) when all standards were satisfied; **"unclear risk"** when at least one criterion was only partially documented; and **"high risk"** (indicating poor quality) when one or more criteria were not met.

3. Results

3.1 Identification and Selection Trends

Current research patterns reveal a steady rise in investigations focused on artificial intelligence within the dental sector. An initial keyword-driven search yielded a total of **298 publications**. After eliminating duplicate entries, **246 unique articles** were assessed through their titles and abstracts, leading to the exclusion of **202 papers** for lack of relevance. Ultimately, **44 pertinent articles** were chosen for full analysis. A standardized data extraction tool was used to record study characteristics, comparative benchmarks (including AI performance relative to human dental specialists) and outcome measures in forms of **"Superior," "Comparable," and "Suboptimal"** (Table 2)

Table- 2 Comparative Analysis of AI Architectures and Clinical Outcomes in Modern Dental Practice

Reference (Author, Year)	Primary Research Goal	Sample Size	Imaging Modality	AI Architecture	Diagnostic Metric	Comparator	Outcome	Key Clinical Conclusion
Umaphy et al. 2024 ¹⁶	Advanced staging of oral carcinoma through deep learning	2,500 images	CT Scans	OCS-Net (GAN-Genetic)	98.05% Accuracy; 98.07% AUC	Transfer Learning	Superior	OCS-Net surpassed traditional models in identifying early-stage malignancies.
Wood et al. (2023) ¹⁷	Post-pubertal mandibular growth prediction	163	Digital Cephalometrics	ML Model	95.8% – 98.3% Accuracy	1 Investigator	Comparable	No significant accuracy differences found between various ML techniques.
Alqahtani et al. (2023) ¹⁸	Bracketed teeth segmentation/classification	215	CBCT	CNN	100% Accuracy; 0.99 AUC	Two Experts	Superior	Tool remains highly accurate and efficient even with orthodontic hardware present.
Kim et al. (2023) ¹⁹	Fishman's skeletal maturity assessment	2,593	Radiographs	Automated DL	0.599 Accuracy; 0.499 MAE	Orthodontists	Superior	Successful automation of widely used skeletal maturation indicators.
Zhu et al., (2023) ²⁰	Multi-task detection of caries and impacted teeth	4,500 OPGs	Panoramic Radiographs	BDU-Net ("Bi-directional" variant of the U-Net architecture) & nnU-Net (no-new-U-Net)	AUC range: 0.77–0.98	Clinical Records	Superior	Demonstrated high clinical specificity for simultaneous multi-pathology screening.
Fontenele (2023) ²¹	<i>Redundant entry: Alveolar segmentation</i>	141	CBCT	CNN	92.0 IoU	2 Observers	Comparable	Re-confirms AI's role in creating consistent digital implant workflows.

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Kim et al. (2022)²²	Sagittal skeletal relationship classification	1,574	Lateral Cephalogram	DCNN	0.96 Accuracy; 0.97 Specificity	Not listed	Superior	DCNN performance surpassed that of existing automated tracing software.
Deif et al. (2022)²³	OSCC diagnosis using deep neural nets	1,224	Histopathology	VGG16, AlexNet	96.3% Accuracy	Not listed	Superior	Integrated models improve diagnostic throughput while minimizing costs.
Al-Sarem et al. (2022)²⁴	3D missing tooth area planning	500	CBCT	DenseNet169	93.3% Accuracy	Implant Expert	Superior	Automated planning tools offer significant time savings for implantologists.
Fati et al., (2022)⁸	Early OSCC detection via fused feature techniques	5,192 images	Histopathology	Hybrid CNN-SVM	99.1% Accuracy; 99.5% Sensitivity; 99.6% Specificity	Pathologist	Superior	Hybrid models achieved near-perfect precision for early cancer identification.
Zheng et al. (2021)²⁵	Analyzing radiographic depth of carious lesions	844 cases	IOPA	ResNet18 (Multi-modal)	0.82 Accuracy (ResNet18)	5 Dentists	Superior	Multi-modal CNNs effectively differentiate between deep caries and pulpitis.
Choi et al. (2021)²⁷	Clinical utility of AI for TMJOA via OPG	1,189	OPG	CNN	0.78 Accuracy; 0.82 Spec	OMFS Experts	Superior	AI bridges the gap in clinics lacking specialized CBCT or radiology experts.
Mao et al. (2021)²⁸	Caries/lesion analysis via transfer learning	1,079	Bitewing	AlexNet, GoogleNet, VGG19	95.5% Restoration Accuracy	Experts	Superior	Transfer learning significantly optimizes clinical time and classification accuracy.
Kim et al. (2021)²⁹	Predictive accuracy vs. network depth	960	Lateral Cephalogram	ResNet series	97.9% AUC (ResNet18)	Not listed	Superior	Network depth (ResNet-18) optimizes medical image prediction performance.

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Park et al. (2021)³⁰	Prediction models for ECC vs regression	4,195	DMFT	4 ML Models	0.785 AUROC	Dentists	Superior	Predictive ML models are a critical first step in preventing childhood caries.
Li et al. (2021)³¹	Multi-task disease detection model	3,932	Oral Photos	CNN	87.1% AUC (Gingivitis)	3 Dentists	Comparable	Oral photography paired with DL is viable for mass population screening.
Verhelst et al. (2021)²⁶	Automated 3D mandibular surface modeling	160	CBCT	Layered DL	94.6% IoU	2 Experts	Superior	AI methods produce 3D models more reliably than traditional manual efforts.
Orhan et al. (2021)¹²	Classification of TMJ pathologies	214	MRI	ML Model	0.77 Testing AUC	2 Radiologists	Superior	ML models can classify condylar changes and disc displacements accurately.
Shaheen et al. (2021)¹⁵	Automatic tooth segmentation via CBCT	186	CBCT	3D U-Net	0.98 Precision	2 Experts	Comparable	Model effectively reduces expert workload in complex segmentation tasks.
Kuwana et al. (2021)¹¹	Maxillary sinus lesion detection	5,872	OPG/CT	Detect Net	90–91% Accuracy	Not listed	Superior	DL models effectively identify various maxillary sinus pathologies.
Thanathornwong et al. (2020)³²	Detection of periodontally compromised teeth	100 cases	OPG	Faster R-CNN	0.84 Sensitivity; 0.88 Specificity; 0.81 F1	Periodontists	Superior	Faster R-CNN reduces diagnostic effort and automates screening records.
Geetha et al. (2020)⁹	Diagnostic system for dental care issues	105	IOPA	BPNN	97.1% Accuracy; 0.987 ROC	Dentist	Comparable	Back propagation networks demonstrate superior predictive accuracy for caries.

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Kunz et al (2020)³³	Landmarks	50	Cephalometric radiographs	Anatomical cephalometric X-ray analysis using specialized (AI) algorithm	Not Clear	12 experienced examiners	Superior	AI algorithm was able to analyse unknown cephalometric X-rays similar to the quality level of the experienced human examiners
Yu et al. (2020)³⁴	Integrated skeletal diagnostic system	5,890	Lateral Cephalogram	CNN	96.4% Vertical Accuracy	Orthodontists	Superior	Automated systems can produce diagnoses directly from raw X-ray inputs.
Vila-Blanco et al. (2020)³⁵	Chronological age estimation via OPG	2,289	OPG	DANet, DASNet	DASNet > DANet	Dental Expert	Superior	DASNet accurately predicts age, particularly in developing dentitions.
Martino et al. (2020)³⁶	Pixel-wise OSCC analysis methods	188	Histopathology	SegNet, U-Net	Data unclear	Pathologists	Suboptimal	Public dataset creation (ORCA) is the primary contribution to future research.
Chang et al. (2020)³⁷	Automated periodontitis staging method	340	OPG	DL Model	0.91 Intra-class Correlation	Radiologists	Superior	Facilitates precise monitoring and diagnosis of periodontal disease levels.
Kurt Bayrakdar (2020)³⁸	Alveolar bone loss detection from OPG	2,276	OPG	CNN	0.91 Accuracy	2 Specialists	Superior	Facilitates future treatment planning and diagnosis for oral physicians.
Lee et al. (2020)³⁹	Dental implant system identification	10,770	Radiographs	CNN	0.971 AUC	Periodontist	Superior	DL architectures are highly useful for classifying various implant systems.
Cantu et al. (2020)¹⁰	Automated caries lesion detection	3,686	Bitewing	CNN	0.80 Acc; 0.83 Specificity	4 Experts	Superior	Trained CNN models outperformed the majority of participating dentists.

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Patil et al. (2020)¹³	Gender prediction for forensic use	509	OPG	ANN	75% Accuracy	Not listed	Superior	ANNs provide a reliable and accurate tool for forensic gender determination.
Kuwada et al. (2020)⁴⁰	Classifying maxillary supernumerary teeth	550	OPG	Detect Net	1.0 Recall/Prec/F1	2 Radiologists	Superior	AI provides robust support for interpreting complex panoramic radiographs.
Hiraiwa et al. (2019)⁴¹	Molar root morphology classification	760	CBCT/OPG	AlexNet, Google Net	0.87 AUC (AlexNet)	Radiologists	Superior	DL systems outperformed human radiologists in differentiating root structures.
Casalegno et al. (2019)⁴²	Caries detection via near-infrared imaging	217	Grayscale TI	CNN	72.7% IOU (5-class)	Experts	Superior	AI automation enhances the speed and precision of identifying dental lesions.
Fukuda et al. (2019)⁴³	Detection of vertical root fractures (VRF)	300	OPG	CNN	0.93 Precision	3 Specialists	Superior	AI provides a reliable diagnostic aid for identifying vertical tooth fractures.
Krois et al. (2019)⁴⁴	PBL detection on OPG image segments	2,001	OPG	CNN	0.81 Accuracy	6 Dentists	Comparable	DL shows similar diagnostic performance to experienced dental professionals.
Yamaguchi (2019)⁴⁵	Predicting debonding of CAD/CAM crowns	8,640	JPEG	CNN	High Prec/Recall	Not listed	Superior	CNNs successfully predict failure probabilities for composite crowns.
Zhang et al. (2018)⁴⁶	Predicting postoperative facial swelling	100	Dataset	ANN	Accuracy- 98.00%	One Oral surgeon	Superior	AI model accurately predicted the facial swelling following the impacted third Molar extraction
Lee et al (2018)⁴⁷	Diagnosing of Periodontally Compromised Teeth (PCT)	348	IOPA	CNN	Accuracy- 78.9%	3 Periodontists	Superior	The DCNN model was effective in diagnosis of PCT

Positive/Negative Predictive Values, F = F-measure; MAE= Mean Absolute Error

ICC = Intraclass Correlation Coefficient, AUC = Area Under the Curve, VRF = Vertical Root Fracture,

3.2 Methodological Quality Analysis

Utilizing the modified QUADAS-2 tool to evaluate study quality, findings showed that **76% of the literature** exhibited a **high risk of bias** regarding patient selection, a trend often attributed to the use of single-center data and vaguely defined eligibility criteria. Conversely, the **reference standard** maintained a **low risk of bias**, as most studies adhered to rigorous validation techniques and standardized protocols. Furthermore, the **index test (92%)** and **procedural timings (89%)** frequently displayed a **low risk of bias** throughout this systematic review.

DISCUSSION:

The Evolving Landscape of AI in Dentistry

The synthesized data from above contemporary studies reveals a transformative shift in dental diagnostics, characterized by a transition from traditional manual assessment to high-precision automated systems.

1. Benchmarking Diagnostic Superiority

The primary finding across the literature is the consistent ability of **Deep Learning (DL)** to meet or exceed human benchmarks. Notably, in oncology, architectures like **OCS-Net** and **Hybrid CNN-SVM** models¹⁹ (Umaphathy et al., 2024; Fati et al., 2022) achieved near-perfect accuracy (>98%) in identifying oral malignancies. This suggests that AI is no longer just a supportive tool but a high-sensitivity screening mechanism that can identify early-stage pathologies often missed by the human eye.

2. Architectural Diversification and Modality Integration

The technological scope has expanded beyond basic **Convolutional Neural Networks (CNNs)**. The data highlights a sophisticated use of **Generative Adversarial Networks (GANs)**, **3D U-Nets**, and **Layered DL** to handle complex 3D data from **CBCCT** and **MRI** scans. For instance, the automation of 3D mandibular surface modeling (Verhelst et al., 2021)²⁶ and volumetric periapical lesion detection (Orhan et al., 2021)¹² demonstrates that AI can manage spatial complexities with high **Intersection over Union (IoU)** scores, ensuring that digital workflows in implantology and endodontics are both consistent and reproducible.

3. Clinical Workflow and Resource Optimization

A critical outcome identified in the review is the democratization of specialized knowledge. Tools designed for **TMJ analysis** and **maxillary sinus screening** (Choi et al., 2021; Kuwana et al., 2021)^{27,11} act as "expert bridges," providing specialized radiological insights in general practice settings. Furthermore, the automation of repetitive tasks—such as cephalometric tracing and periodontal staging—not only minimizes the risk of clinician fatigue but also significantly reduces the operational time required for treatment planning.

4. Critical Challenges and Data Reliability

Despite the overwhelmingly positive outcomes, the analysis reveals a "neutral" performance in certain predictive areas, such as mandibular growth forecasting (Wood et al., 2023).¹⁷ This indicates that while AI excels at **classification and segmentation**, its ability to predict longitudinal

biological changes remains a frontier for development. Additionally, the success of these models is heavily dependent on the quality of training data, highlighting the need for expansive, multi-center datasets to ensure that AI performance remains robust across diverse patient populations.

CONCLUSION

The adoption of AI in dentistry signifies a paradigm shift, providing profound enhancements in diagnostic precision, therapeutic strategy, and the standard of patient services. While the advantages are clear, integrating these systems necessitates addressing critical hurdles, including the implementation of robust data confidentiality standards, the mitigation of excessive technological dependency, and the execution of persistent verification to guarantee the long-term reliability of AI tools.

In summary, AI serves not as a replacement for the dental practitioner, but as a sophisticated supplementary resource that strengthens clinical work through individualized care and more accurate assessments. Navigating the future of dental medicine will require a careful equilibrium between leveraging AI's computational power and maintaining human clinical expertise, particularly as ethical frameworks and technological capabilities continue to advance

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