South American Publishing

SAP Artificial Intelligence in Dentistry. 2026; 2:51
doi: 10.62486/aid202651

REVIEW

# Artificial intelligence in dentistry: clinical applications, ethical challenges and future perspectives

## Inteligencia artificial en odontología: aplicaciones clínicas, desafíos éticos y perspectivas futuras

Isis Scarleth Funes Galindo[1], Freddy Ednildon Bautista-Vanegas[2,3], Jhossmar Cristians Auza-Santivañez[4], Blas Apaza-Huanca[5], Jose Daniel Vargas-Jimenez[6], Fidel Aguilar Medrano[7], Jaykel Evelio Gómez Triana[8], Leonel Rivero Castedo[9], Carlos Daniel Echazú Torres[10], Yenny Cruz Nuñez[4]

[1]Instituto Nacional de Previsión del Magisterio. Clínica municipal de emergencias Talanga. Honduras.
[2]Kliniken Beelitz GmbH Neurologische Rehabilitationsklinik: Beelitz Heilstätten, Brandenburg, DE. Alemania.
[3]Neurologisches Fachkrankenhaus für Bewegungsstörungen / Parkinson: Beelitz Heilstätten, Brandenburg, DE. Alemania.
[4]Hospital del Gran Chaco "Fray Quebracho" de III Nivel. Unidad de Cuidados Intensivos. Tarija, Bolivia.
[5]Ministerio de Salud y Deportes. Instituto Académico Científico Quispe-Cornejo. La Paz, Bolivia.
[6]Centro Médico San Martin. Fundación Medica Solidaria. Yacuiba, Bolivia.
[7]Hospital Municipal de Morón Ostaciana B. De Lavignolle, Buenos Aires, Argentina.
[8]Centro de Salud Nuestra Señora del Castillo. Sevilla, España.
[9]Universidad Privada Franz Tamayo (UNIFRANZ). Facultad de Ciencias de la Salud. Santa Cruz, Bolivia
[10]Ministerio de Salud y Deportes. La Paz, Bolivia.

**Cite as**
Funes Galindo IS, Bautista-Vanegas FE, Auza-Santivañez JC, Apaza-Huanca B, Vargas-Jimenez JD, Aguilar Medrano F, et al. Artificial intelligence in dentistry: clinical applications, ethical challenges and future perspectives. SAP Artificial Intelligence in Dentistry. 2026; 2:51. https://doi.org/10.62486/aid202651

**Publication History**
**Submitted:** 22-09-2025
**Revised:** 01-11-2025
**Accepted:** 22-12-2025
**Published:** 01-01-2026

**Corresponding Author**
Isis Scarleth Funes Galindo

**ABSTRACT**

**Introduction:** artificial intelligence (AI) has progressively transformed healthcare across multiple specialties. In dentistry, deep learning algorithms and convolutional neural networks have demonstrated diagnostic accuracy comparable to, and in certain contexts superior to, that of experienced clinicians. This narrative review synthesizes the current evidence on AI applications in dentistry, with particular attention to the ethical challenges and specific barriers faced in Latin American contexts, including Bolivia.

**Method:** a narrative review of the scientific literature was conducted using PubMed, Scopus, and Google Scholar. Articles published between 2025 and 2026 were included, prioritizing systematic reviews, meta-analyses, and peer-reviewed original studies. The following MeSH terms were used: "artificial intelligence," "dentistry," "ethics," "machine learning," and "oral diagnosis."

**Development:** the first diagnostic support systems were explored in the 1980s and 1990s. The qualitative leap came with deep learning and CNNs, which allow for the analysis of radiographic images with a granularity that, in many contexts, surpasses inter-observer variability. CNN-based systems have demonstrated consistent results in caries detection, periodontal evaluation, identification of periapical lesions, and diagnosis of maxillary pathologies in panoramic, periapical, and cone-beam computed tomography (CBCT) radiographs. AI has generated particularly robust results in automated cephalometric analysis.

**Conclusions:** AI in dentistry has reached clinical maturity in diagnosis, showing accuracy comparable to or better than that of human experts, especially in dental radiology. Its implementation in Latin America and Bolivia is conditioned by structural inequalities, such as low investment, a lack of local data, and limited digitization, which could widen health gaps if not addressed adequately. The future of dentistry will depend not only on how much AI is used, but also on how well technology is balanced with the professional's responsibility, ethics, and clinical judgment.

**Keywords:** Adolescents, health, dietary habits, food consumption, nutrition, nursing.

**RESUMEN**

**Introducción:** la inteligencia artificial (IA) ha transformado progresivamente la atención en salud en múltiples especialidades. En odontología, los algoritmos de aprendizaje profundo y las redes neuronales convolucionales han demostrado una precisión diagnóstica comparable y en ciertos contextos superior a la de los clínicos experimentados. Esta revisión narrativa sintetiza la evidencia actual sobre las aplicaciones de IA en odontología, con atención particular

© 2026; The Authors. This Open access article is distributed under the Creative Commons Attribution 4.0 license (https://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

a los desafíos éticos y a las barreras específicas que enfrentan los contextos latinoamericanos, incluido Bolivia.

**Método**: se realizó una revisión narrativa de la literatura científica mediante búsqueda en PubMed, Scopus y Google Scholar. Se incluyeron artículos publicados entre 2025 y 2026, priorizando revisiones sistemáticas, metaanálisis y estudios originales con revisión por pares. Se utilizaron términos MeSH: "artificial intelligence", "dentistry", "ethics", "machine learning" y "oral diagnosis".

**Desarrollo:** los primeros sistemas de apoyo diagnóstico se exploraron en los años ochenta y noventa, el salto cualitativo llegó con el deep learning y las CNN, que permiten analizar imágenes radiográficas con una granularidad que supera en muchos contextos la variabilidad inter observador. Los sistemas basados en CNN han demostrado resultados consistentes en la detección de caries, evaluación periodontal, identificación de lesiones periapicales y diagnóstico de patologías del maxilar en radiografías panorámicas, periapicales y tomografías de haz cónico (CBCT). la IA ha generado resultados especialmente robustos en el análisis cefalométrico automatizado.

**Conclusiones:** la IA en odontología ha alcanzado madurez clínica en diagnóstico, mostrando precisiones comparables o superiores al experto humano, especialmente en radiología dental. La implementación en América Latina y Bolivia, está condicionada por desigualdades estructurales, como baja inversión, falta de datos locales y limitada digitalización, lo que puede ampliar brechas en salud si no se aborda adecuadamente. El futuro de la odontología no dependerá solo de cuánta IA se utilice, sino de cómo se equilibre la tecnología con la responsabilidad, la ética y la mirada clínica del profesional.

**Palabras clave:** Inteligencia Artificial; Odontología; Aprendizaje Profundo; Radiología Diagnóstica; Ética; Precisión Diagnóstica.

## INTRODUCTION

Artificial intelligence (AI) is currently among the most actively studied technologies in medicine, and dentistry is no exception. In simple terms, AI systems in healthcare analyze large volumes of data—images, medical records, and biological signals—and extract patterns that escape the human eye or processing capacity. In dentistry, deep learning algorithms, particularly convolutional neural networks (CNNs), have been applied with consistent results in diagnostic imaging, treatment planning, and clinical management.[1,2] The numbers leave little room for doubt. In recent systematic reviews, AI models for caries detection achieved sensitivity rates ranging from 82–94 % and specificity rates ranging from 86–95 %. Automated cephalometric analysis achieves agreement rates of 95–98 % with those of orthodontic experts.[1,3] These results are difficult to ignore, although they have significant limitations related to prospective clinical validation. Globally, the development of AI in healthcare has been driven by mature digital infrastructures, access to large clinical databases, and levels of investment in research that most middle-income countries cannot match. Latin America accounts for 8,8 % of the world's population but only 1,12 % of global investment in AI, according to the ECLAC's *Latin American Artificial Intelligence Index*.[4] This gap directly determines the types of tools that can be developed and validated in the region.

Bolivia clearly illustrates these contrasts. The healthcare system shows marked differences between urban and rural areas, with shortages of specialized personnel and a digitization of dental services that remains fragmented as of 2026. The use of AI-based tools is, in practice, restricted to academic settings or isolated projects.[4,5] Algorithms trained on high-income populations tend to perform worse in underrepresented ethnic groups, turning the Latin American data gap into a concrete clinical problem.[6] Adding to these structural limitations are ethical questions that no Latin American regulatory framework has yet satisfactorily addressed: Who is held accountable when an algorithm fails to diagnose a malignant lesion? How can we ensure that patient data are not reused without consent? How is a model audited that no one outside the laboratory that developed it fully understood? These are uncomfortable but necessary questions.[5,7]

The objective of this narrative review is to analyze the current state of artificial intelligence in dentistry, describe its main clinical applications with an emphasis on diagnosis and radiology, examine the documented benefits and known ethical challenges, and identify implementation limitations with special attention to the Latin American and Bolivian contexts.

## METHOD

A narrative literature review was conducted during the period from October 2025 to March 2026, with the aim of synthesizing the available evidence on the application of artificial intelligence in dentistry, its ethical implications, and future prospects. The literature search was conducted in high-impact databases, including PubMed/MEDLINE, Scopus, SciELO, the Cochrane Library, and Google Scholar, supplemented by searches on specialized platforms such as ClinicalKey. The search strategy employed MeSH (Medical Subject Headings) terms and free-text keywords, combined with the Boolean operators "AND" and "OR," with the syntax adapted to each database. The terms used included "artificial intelligence," "dentistry," "ethics," "machine learning," "oral diagnosis," "deep learning," "convolutional neural network," and "dental radiology," as well as their Spanish equivalents. The inclusion criteria were articles published between 2018 and 2026, in English or Spanish, addressing clinical applications, ethical aspects, or technological developments of artificial intelligence in dentistry. Studies with a higher level of scientific evidence, including systematic reviews, meta-analyses, peer-reviewed original studies, clinical trials, observational studies, and relevant narrative reviews, were prioritized. Duplicate documents, unvalidated gray literature, articles without full-text access, and those not directly related to the study's objective were excluded. The collected information was organized through a thematic analysis and structured into the following categories: clinical applications, benefits, ethical challenges, the Latin American context, and limitations of the evidence. Given the narrative nature of the review, a systematic assessment of the methodological quality of the studies was not performed; instead, a critical synthesis focused on the clinical and contextual interpretation of the findings was conducted.

## DEVELOPMENT

### Clinical applications of artificial intelligence in dentistry

The history of AI in dentistry is longer than is commonly recognized: the first diagnostic support systems were explored in the 1980s and 1990s, although they were limited by the computational capacity of the time.[1] The qualitative leap came with deep learning and CNNs, which allow for the analysis of radiographic images with a granularity that, in many contexts, surpasses human interobserver variability. Wang et al.[8] provide an updated overview of these applications, grouping them into diagnosis, treatment planning, and education.

*Diagnostic imaging and radiology*

This is the field with the most accumulated evidence and, for many specialists, the one with the greatest immediate clinical impact. CNN-based systems have demonstrated consistent results in the detection of dental caries, periodontal assessment, identification of periapical lesions, and diagnosis of maxillary pathologies in panoramic and periapical radiographs and cone-beam computed tomography (CBCT) scans.[1,3] Lee JH et al.[9] published one of the seminal studies in this field, demonstrating that a CNN trained on periapical radiographs detected caries with an accuracy statistically equivalent to that of human experts. Since then, the literature has grown exponentially. A systematic review by Tyagi M et al.[3], which included 47 studies meeting the PRISMA criteria, reported diagnostic sensitivities of 82–94 % for caries and 85–92 % for periodontal assessment in deep learning models. Alaqla A et al.[10] published a specific systematic review on the detection of periapical lesions, which included 28 studies. Their findings indicate that AI models improve the diagnostic ability of dentists in training, narrowing the gap between experts and novices—a relevant finding for systems facing a shortage of specialists.

*In orthodontics*

AI has generated particularly robust results in automated cephalometric analysis. Kunz F et al.[11] evaluated a CNN for comprehensive cephalometric analysis and reported 95–98 % agreement with manual expert analysis, significantly reducing the processing time. Beyond cephalometric analysis, AI systems can predict postsurgical outcomes, automated appliance design, and treatment time estimation. Table 1 summarizes the studies on the diagnostic accuracy of AI in orthodontics identified in this review:

**Table 1.** Diagnostic accuracy of AI in orthodontics

| Author | Findings |
|---|---|
| M'hamed Jihed et al.[12] | The accuracy of AI systems reached 95,47 % in planning and decision-making regarding orthodontic treatments. |
| Del Real A et al.[13] | By generating and comparing various prediction models, an accuracy of 93,9 % was achieved in determining whether or not an extraction is required based on the model and radiographic data. |
| Tanikawa C et al.[14] | The study developed two AI systems to predict 3D facial morphology following orthognathic surgery and orthodontic treatment, with 100 % success when defining success as an error of < 2 mm. |
| Ryu J et al.[15] | Accuracy reached 99,3 % for the classification of facial photographs and 99,9 % for the classification of intraoral photographs. |
| Kök H et al.[16] | They evaluated the analysis of cervical vertebral maturation using AI algorithms with an average accuracy of 77,02 %. |
| Volovic J et al.[17] | The best-fitting model for predicting treatment duration achieved an adjusted coefficient of determination of 0,99. |
| Li P et al.[18] | Neural network models show 94,0 % accuracy for predicting extraction versus nonextraction. The accuracies for extraction patterns and anchorage patterns are 84,2 % and 92,8 %, respectively |
| Kunz F et al.[11] | Fully automated CNN for cephalometric analysis: 95,98 % agreement with manual expert analysis; significant reduction in processing time. |
| Lahoud P et al.[19] | Deep learning model for cephalometric point detection; mean radial error of 1,25 mm, comparable to that of a human examiner. |
| Arslan A et al.[20] | Automatic classification of skeletal malocclusions using CNN on lateral radiographs; 91,4 % accuracy for Classes I, II, and III. |
| Ngan T et al.[21] | Prediction of the need for refinements with clear aligners using AI; AUC 0,88. |
| Mahdi SS et al.[22] | Detection of orthodontically induced apical root resorption on CBCT; sensitivity 87 %, specificity 93 %. |

*Implantology and oral surgery*

In implantology, AI-integrated CAD/CAM systems for surgical planning report agreement rates of up to 96 % with expert strategies. Revilla-León M et al.[23] systematically reviewed AI applications in dental implantology, documenting improvements

in predicting implant success through preoperative tomographic analysis and machine learning models. Applications range from selecting implant size and position to the early detection of peri-implantitis in radiographic follow-ups.

*Pediatric dentistry*

One of the areas with the most recent publications is pediatric dentistry. The meta-analysis by Karamüftüoğlu N et al.[24], registered in PROSPERO, using the PRISMA-DTA methodology and including 18 studies, reported pooled sensitivity and specificity consistent with those obtained in adults for the detection of early childhood caries (ECC), estimation of dental age, and assessment of root maturation. However, the authors noted that most models were trained using data from Asian or European populations, which limits their direct generalization to Latin American contexts.

*Generative artificial intelligence*

An emerging trend is the use of generative AI diffusion models, generative adversarial networks (GANs), and large-scale language models (LLMs) in dentistry. Current applications include digital crown design, dental alignment simulation, educational content generation, and radiographic diagnosis assistance. Wang X et al.[8] devoted a specific section to these applications in their narrative review. This is still a field with insufficient clinical validation, but the pace of publications suggests that within the next two or three years, there will be more robust evidence regarding its clinical viability.

**Table 2.** Development of artificial intelligence in dentistry

| Year | Author/Study | Study type | Area | Main results |
|---|---|---|---|---|
| 2018 | Lee JH et al.[9] | Experimental (CNN) | Caries diagnosis | Diagnostic accuracy comparable to human experts; neural network for caries detection in periapical radiographs. |
| 2019 | Topol EJ[7] | Narrative review | Medicine and AI | AI outperforms or matches human performance in diagnostic imaging, electrocardiography, and dermatology. |
| 2020 | Schwendicke F et al.[2] | Narrative review | Medicine and AI | AI improves diagnosis and clinical efficiency; highlights implementation challenges and ethical issues. |
| 2020 | Morley J et al.[5] | Mapping review | Health Ethics | Identification of four dominant ethical principles for AI in healthcare: beneficence, nonmaleficence, autonomy, and justice. |
| 2020 | Kunz F et al.[11] | Experimental (CNN) | Orthodontics | High accuracy (95–98 %) in automated cephalometric analysis compared to manual analysis by experts. |
| 2021 | Khanagar SB et al.[25] | Systematic review | Medicine and AI | High performance in diagnosis and clinical planning; reports gaps in data standardization. |
| 2021 | Revilla-León M et al.[23] | Systematic review | Implantology | Improvements in Surgical Planning and Prediction of Implant Success Using CNN Models and Computed Tomography. |
| 2023 | Ding H et al.[26] | Narrative review | Medicine and AI | AI improves clinical efficiency and evidence-based decision support; identifies gaps in prospective validation. |
| 2024 | Rokaya D et al.[27] | Systematic review | Radiology / Prosthetics | AI enables precise segmentation and analysis of CBCT dental images; applications in computer-aided prosthetic design. |
| 2025 | Tyagi M et al.[3] | Systematic review | Medicine and AI | AI improves diagnostic accuracy (82–94 % for caries; 85–92 % for periodontics) and operational efficiency across multiple specialties. |
| 2025 | Alaqla A et al.[10] | Systematic review | Endodontics | AI models improve detection of periapical lesions in 28 studies; greater benefit for less experienced dentists. |
| 2025 | Ara S et al.[1] | Systematic review | Medicine and AI | 79 % of studies are retrospective; critical gap between laboratory performance and prospective clinical validation. |
| 2026 | Karamüftüoğlu N et al.[24] | SR + Meta-analysis | Pediatric dentistry | Consistent pooled sensitivity and specificity for detecting early childhood caries; bias due to predominance of Asian and European data. |
| 2026 | Krishna Prasad B[28] | Systematic review | Ethics and regulation | Urgent need for specific legal frameworks for dental AI; regulatory gaps in low- and middle-income countries. |

**Clinical benefits**

The most consistent benefit reported in the literature is improved diagnostic accuracy and reduced interobserver variability. Schwendicke F et al.[2] demonstrated that AI systems significantly reduce variability among professionals in the detection of caries on radiographs, a finding with direct implications in high-demand healthcare settings. The automation of routine processes—radiographic analysis, preliminary diagnosis, and medical record management—reduces the professional's cognitive load and frees up time for more complex tasks. Khanagar SB et al.[25] systematically reviewed AI performance across multiple dental specialties and concluded that the benefits are robust in diagnostic imaging but still nascent in administrative management. Predictive models for treatment planning in orthodontics and implantology allow for more predictable outcomes and reduce complications. Revilla-León M et al.[23] reported that AI systems applied to preoperative CT scans improve implant selection and reduce the risk of surgical complications in complex cases. A less-discussed but equally relevant benefit is educational potential. AI-based clinical simulation tools allow students to practice diagnosis in complex cases and receive immediate feedback. Topol EJ[7] noted that AI can become a personalized tutor for medical diagnosis, accelerating the learning curve in training systems with limited access to patients.

Finally, the trend toward data-driven dentistry represents a paradigm shift: clinical decisions are no longer based solely on individual experience but are increasingly integrated with the analysis of large volumes of population-based data. When managed effectively, this shift can objectively improve the quality of care. When mismanaged, it can perpetuate biases on a large scale.[1,2]

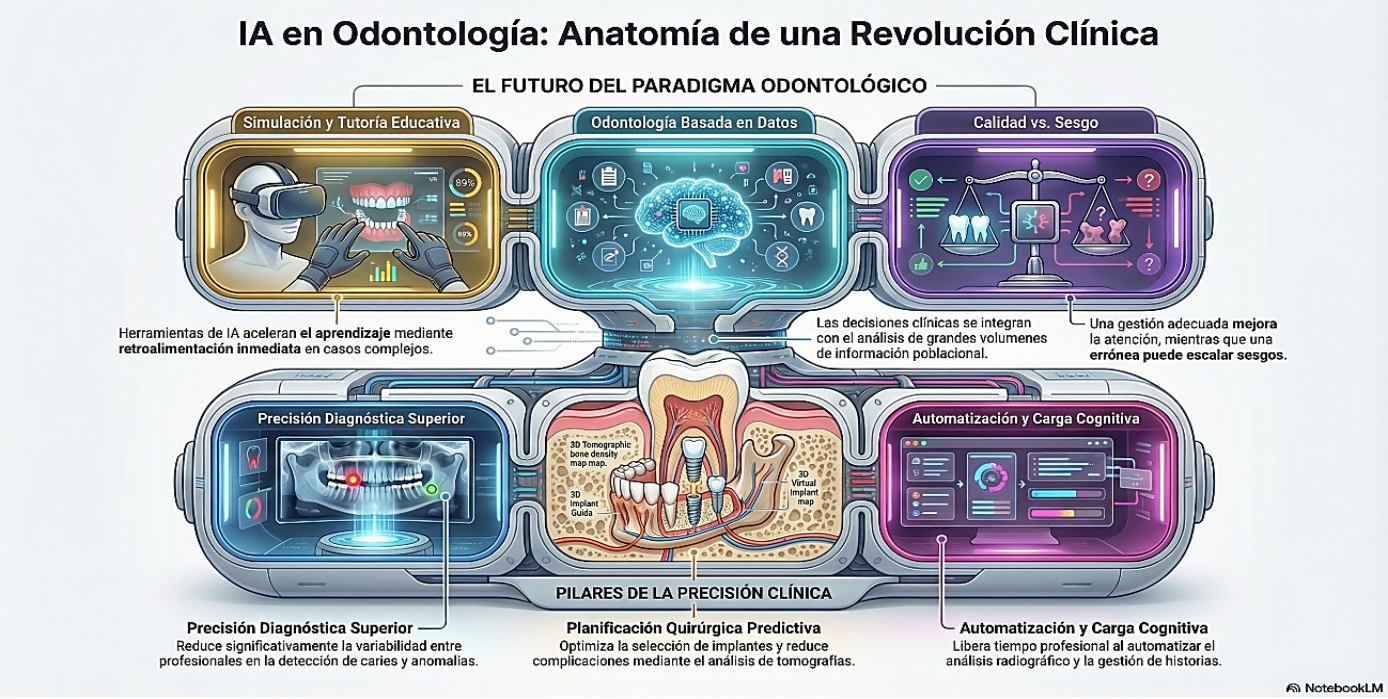


**Figure 1**. AI in Dentistry: Anatomy of a Clinical Revolution

**Ethical challenges**

The systematic review by Krishna Prasad B[28], registered with OSF using the PRISMA 2020 methodology, is arguably the most recent and comprehensive synthesis of the ethical and legal challenges of AI in dentistry. Its findings confirm that the problems identified five years ago remain unresolved and that the gap between technical advancement and regulatory development has widened and not narrowed.

**Data privacy and confidentiality**

AI models in dentistry require large volumes of patient data for training, such as X-rays, CT scans, medical records, and demographic information. In contexts lacking robust data protection frameworks, such as Bolivia, where digital health regulations are still under development, the risks of misuse of this information are very real. Morley J et al.[5] reported privacy as the most frequently mentioned ethical principle in the literature on AI in healthcare, appearing in 85 % of the policy documents analyzed.

**Algorithmic transparency**

The "black box" problem is real and unresolved. Most high-performance deep learning models do not allow for a direct interpretation of how a decision is generated. Topol EJ[7] explicitly raised this issue: without explainability, AI in medicine poses risks of overdiagnosis and blind trust in the algorithm. Krishna Prasad B added that the demand for explainability is not a regulatory whim but a clinical necessity in specialties where decisions have irreversible consequences.

**Algorithm biases and health equity**

AI algorithms are not neutral: they learn from the data used to train them. If those data come predominantly from populations in

Europe, the United States, or East Asia, the model's performance in underrepresented groups may be significantly lower. Rajkomar A et al.[6] systematically documented this phenomenon in healthcare, demonstrating that models trained with biased data reproduce and amplify existing inequities in the healthcare system. In the Latin American context, where indigenous and mestizo populations are underrepresented in global databases, this risk takes on a particular dimension.

**Professional liability**

If an AI system issues an erroneous diagnosis that leads to incorrect treatment, who is liable: the software developer, the dentist who relied on it, or the institution that acquired it? Gerke S, Minssen T, and Cohen G analyzed this problem in detail and concluded that current legal frameworks designed for individual professional liability are not prepared to manage the distribution of responsibilities in clinical systems with integrated AI.[29] Krishna Prasad B[28] confirmed that as of 2026, no low- or middle-income country has specific regulations for AI in dentistry.

**Latin American Perspective and Implementation Challenges**

Latin America accounts for 1,12 % of global spending on AI, despite representing nearly 9 % of the world's population, according to the ECLAC's 2025 Latin American Artificial Intelligence Index (ILIA).[4] This figure encapsulates the structural problem. In dentistry, this gap translates into a reliance on tools developed in other contexts, limited production of models trained with proprietary data, and a lack of validation protocols adapted to regional reality. The specific obstacles are well known: insufficient technological infrastructure in public health systems, nonstandardized and noninteroperable clinical data, irregular connectivity in rural areas, and professional training that, in most Latin American dental schools, still does not incorporate basic digital skills.[4,5] However, the outlook is not entirely bleak. Quintero-Rojas J[30] highlighted in an editorial that diagnostic AI projects have been developed in Latin America with minimal investment and technically acceptable results, training low-cost image recognition models using local databases. These experiences suggest that the region does not need to wait to match the infrastructure of developed countries to begin producing its own tools. Institutional will, data-sharing policies, and training programs that place digital literacy at the center of dental education are needed.

In Bolivia specifically, the digitization of dental services also faces the challenge of the heterogeneity of the healthcare system: the differences between tertiary-level urban centers, where some digital imaging equipment is available, and primary- and secondary-level facilities in rural areas are so marked that any AI implementation strategy must be designed by level and context, not as a uniform policy.

**Limitations of the current evidence**

A systematic review by Ara S et al.[1] revealed that 79 % of studies on AI in dentistry are retrospective and were conducted in controlled research settings. This means that most of the available accuracy data reflect the model's performance under ideal conditions—curated datasets, high-quality images, and selected samples—rather than its performance amid real-world variability. This is perhaps the most serious methodological problem in the field: there is a well-documented gap between laboratory performance and prospective clinical validation. Studies with retrospective designs using image archives tend to overestimate accuracy; the few studies that evaluated performance under real-world clinical conditions report more modest results. This limitation is highlighted by Ding H et al.[26], who reported that most published models lack external validation with independent data. Adding to this are specific limitations: a population bias toward Asian and European data that reduces generalizability to Latin American contexts; considerable heterogeneity in the reported evaluation metrics (sensitivity, specificity, AUC, F1 score), which hinders comparisons between studies; and a scarcity of cost-effectiveness studies that would allow for a rigorous assessment of economic viability in resource-limited settings.

This review has certain limitations; as it is narrative, it does not apply systematic selection criteria, nor does it formally assess the quality of the included studies. Its objective is to provide a synthesis oriented toward clinical practice and the Latin American context.

## CONCLUSIONS

AI in dentistry has reached clinical maturity in diagnosis, demonstrating accuracy comparable to or superior to that of human experts, especially in dental radiology, positioning it as a valid, evidence-based tool. The ethical challenges are structural and unresolved, highlighting issues of privacy, algorithmic bias, model opacity, and gaps in professional liability for errors. Implementation in Latin America and Bolivia in particular is constrained by structural inequalities, such as low investment, a lack of local data, and limited digitization, which may widen health disparities if not adequately addressed. The future of dentistry will depend not only on how much AI is used but also on how technology is balanced with responsibility, ethics, and the clinician's professional judgment.

## FINANCING

The authors received no funding for this study.

## CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

## AUTHORSHIP CONTRIBUTION

*Conceptualization:* Isis Scarleth Funes Galindo, Jhossmar Cristians Auza-Santivañez.
*Data curation:* Jhossmar Cristians Auza-Santivañez.
*Formal analysis:* Isis Scarleth Funes Galindo, Blas Apaza-Huanca.
*Research:* Isis Scarleth Funes Galindo, Jhossmar Cristians Auza-Santivañez.
*Methodology:* Freddy Ednildon Bautista-Vanegas.
*Project Management:* Jhossmar Cristians Auza-Santivañez.
*Resources:* Isis Scarleth Funes Galindo, Freddy Ednildon Bautista-Vanegas.
*Software:* Freddy Ednildon Bautista-Vanegas.
*Supervision:* Blas Apaza-Huanca.
*Validation:* Blas Apaza-Huanca.
*Visualization:* Blas Apaza-Huanca.
*Drafting – original draft:* Isis Scarleth Funes Galindo, Freddy Ednildon Bautista-Vanegas, Jhossmar Cristians Auza-Santivañez, Blas Apaza-Huanca, Jose Daniel Vargas-Jimenez, Fidel Aguilar Medrano, Jaykel Evelio Gómez Triana, Leonel Rivero Castedo, Carlos Daniel Echazú Torres, Yenny Cruz Nuñez.
*Writing – review and editing:* Isis Scarleth Funes Galindo, Freddy Ednildon Bautista-Vanegas, Jhossmar Cristians Auza-Santivañez, Blas Apaza-Huanca, Jose Daniel Vargas-Jimenez, Fidel Aguilar Medrano, Jaykel Evelio Gómez Triana, Leonel Rivero Castedo, Carlos Daniel Echazú Torres, Yenny Cruz Nuñez.

## BIBLIOGRAPHIC REFERENCES

1. Ara S, Mirochnik R. Artificial Intelligence Applications in Dentistry: A Systematic Review. Oral. 2025;5(4):90. https://doi.org/10.3390/oral5040090

2. Schwendicke F, Samek W, Krois J. Artificial intelligence in dentistry: chances and challenges. J Dent Res. 2020;99(7):769-774. https://doi.org/10.1177/0022034520915714

3. Tyagi M, Jain S, Ranjan M, et al. Artificial Intelligence Tools in Dentistry: A Systematic Review on Their Application and Outcomes. Cureus. 2025;17(5):e85062. https://doi.org/10.7759/cureus.85062

4. Comisión Económica para América Latina y el Caribe. Índice Latinoamericano de Inteligencia Artificial (ILIA) 2025. Santiago: CEPAL; 2025. Disponible en: https://www.cepal.org/es/publicaciones/ilia-2025

5. Morley J, Machado CCV, Burr C, et al. The ethics of AI in health care: a mapping review. Soc Sci Med. 2020;260:113172. https://doi.org/10.1016/j.socscimed.2020.113172

6. Rajkomar A, Hardt M, Howell MD, Corrado G, Chin MH. Ensuring fairness in machine learning to advance health equity. Ann Intern Med. 2018;169(12):866-872. https://doi.org/10.7326/M18-1521

7. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nat Med. 2019;25(1):44-56. https://doi.org/10.1038/s41591-018-0300-7

8. Wang X, Xia Z, Zhang H, Yu J. Artificial Intelligence in Dentistry: A Narrative Review of Diagnostic and Therapeutic Applications. Med Sci Monit. 2025;31:e946676. https://doi.org/10.12659/MSM.946676

9. Lee JH, Kim DH, Jeong SN, Choi SH. Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. J Dent. 2018;77:106-111. https://doi.org/10.1016/j.jdent.2018.08.005

10. Alaqla A, Khanagar SB, Albelaihi AI, Singh OG, Alfadley A. Application and performance of artificial intelligence-based models in the detection, segmentation and classification of periapical lesions: a systematic review. Front Dent Med. 2025;6:1717343. https://doi.org/10.3389/fdmed.2025.1717343

11. Kunz F, Stellzig-Eisenhauer A, Zeman F, Boldt J. Artificial intelligence in orthodontics: evaluation of a fully automated cephalometric analysis using a convolutional neural network. Angle Orthod. 2020;90(5):669-677. https://doi.org/10.2319/090919-626.1

12. M'hamed Jihed, Dallel I, Tobji S, Ben Amor A. The Impact of Artificial Intelligence on Contemporary Orthodontic Treatment Planning – A Systematic Review and Meta-Analysis. Sch J Dent Sci. 2022;9(5):70-87. https://doi.org/10.36347/sjds.2022.v09i05.001

13. Del Real A, Del Real O, Sardina S, Oyonarte R. Use of automated artificial intelligence to predict the need for orthodontic extractions. Korean J Orthod. 2022;52(2):102-111. https://doi.org/10.4041/kjod.2022.52.2.102

14. Tanikawa C, Yamashiro T. Development of novel artificial intelligence systems to predict facial morphology after orthognathic surgery and orthodontic treatment in Japanese patients. Sci Rep. 2021;11:15853. https://doi.org/10.1038/s41598-021-95002-w

15. Ryu J, Lee YS, Mo SP, Lim K, Jung SK, Kim TW. Application of deep learning artificial intelligence technique to the classification of clinical orthodontic photos. BMC Oral Health. 2022;22:454. https://doi.org/10.1186/s12903-022-02466-x

16. Kök H, Acilar AM, İzgi MS. Usage and comparison of artificial intelligence algorithms for determination of growth and development by cervical vertebrae stages in orthodontics. Prog Orthod. 2019;20:41. https://doi.org/10.1186/s40510-019-0295-8

17. Volovic J, Badirli S, Ahmad S, Leavitt L, Mason T, Bhamidipalli SS, Eckert G, Albright D, Turkkahraman H. A Novel Machine Learning Model for Predicting Orthodontic Treatment Duration. Diagnostics (Basel). 2023;13(17):2740. https://doi.org/10.3390/diagnostics13172740

18. Li P, Kong D, Tang T, Su D, Yang P, Wang H, Zhao Z, Liu Y. Orthodontic Treatment Planning based on Artificial Neural Networks. Sci Rep. 2019;9:2037. https://doi.org/10.1038/s41598-018-38439-w

19. Lahoud P, EzEldeen M, Beznik T, Willems G, Leite A, Van Gerven A, et al. Explainability of deep learning for automated detection of cephalometric landmarks on lateral X-rays. Orthod Craniofac Res. 2022;25(3):399-407. https://doi.org/10.1111/ocr.12566

20. Arslan A, Şen S, Orhan K. Deep learning-based automatic classification of skeletal malocclusion on lateral cephalometric radiographs. Clin Oral Investig. 2024;28(1):58. https://doi.org/10.1007/s00784-023-05406-7

21. Ngan T, Nguyen T, Al-Rawi M, Park J, Mehta P, Rysavy J, et al. Predicting the need for refinements in clear aligner orthodontic treatment: a machine learning approach. Prog Orthod. 2025;26(1):4. https://doi.org/10.1186/s40510-025-00553-5

22. Mahdi SS, Shivakumar S, Ansari SA, Shah RA, Haque M. Artificial intelligence in orthodontic root resorption assessment: a systematic review. Artif Intell Dent. 2026;2:e0020. https://doi.org/10.1002/aid2.20026

23. Revilla-León M, Gómez-Polo M, Vyas S, Barmak AB, Att W. Artificial intelligence applications in implant dentistry: a systematic review. J Prosthet Dent. 2021;125(6):915-922. https://doi.org/10.1016/j.prosdent.2020.10.010

24. Karamüftüoğlu N, Bulut A, Akın M, Sağıroğlu S. Artificial Intelligence in Pediatric Dentistry: A Systematic Review and Meta-Analysis. Children. 2026;13(1):152. https://doi.org/10.3390/children13010152

25. Khanagar SB, Al-Ehaideb A, Maganur PC, et al. Developments, application, and performance of artificial intelligence in dentistry: a systematic review. J Dent Sci. 2021;16(1):508-522. https://doi.org/10.1016/j.jds.2020.11.012

26. Ding H, Wu J, Zhao W, et al. Artificial intelligence in dentistry: a review. Front Dent Med. 2023;4:1085251. https://doi.org/10.3389/fdmed.2023.1085251

27. Rokaya D, Suttagul K, Jaisamut C, Chaodee A, Udomluck T, Krejci I. Artificial intelligence in dental radiology and prosthodontics: A systematic review. J Adv Prosthodont. 2024;16(3):161-175. https://doi.org/10.4047/jap.2024.16.3.161

28. Krishna Prasad B. Artificial Intelligence–Driven Dentistry: A Systematic Review of Ethical and Legal Challenges. Int J Dent. 2026;2026:1870800. https://doi.org/10.1155/ijod/1870800

29. Gerke S, Minssen T, Cohen G. Ethical and legal challenges of artificial intelligence-driven healthcare. Artif Intell Healthc. 2020:295-336. https://doi.org/10.1016/B978-0-12-818438-7.00012-5

30. Quintero-Rojas J. El rol transformador de la Inteligencia Artificial en el pensamiento clínico y científico odontológico. Rev Venez Invest Odont IADR. 2025;13(1):1-5. Disponible en: http://erevistas.saber.ula.ve/index.php/rvio/article/view/21411