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ORIGINAL

Critical and Structured Analysis of AI Development in Dentistry

Análisis crítico y estructurado del desarrollo de la inteligencia artificial en odontología

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ABSTRACT

Introduction: the integration of artificial intelligence in dentistry dates to the late twentieth century, within a context shaped by the increasing computerization of healthcare systems. Early developments focused on reproducing expert reasoning through rule-based systems, particularly in areas where clinical decisions could be formalized.
Method: a qualitative, analytical-interpretive study was conducted based on scientific literature published between the late 1980s and late 1990s, complemented by a corpus and Web of Science searches up to 2000. Historical, historiographic, and ethnographic analyses were performed, along with a bibliometric keyword co-occurrence analysis using VOSviewer.
Results: three phases were identified: institutional experimentation, specialized system development, and clinical validation. A conceptual shift was observed from system construction to performance evaluation, using metrics such as accuracy and agreement. The bibliometric analysis revealed a transition from "systems" and "rules" to concepts related to validation and clinical performance. Gaps were identified in areas such as periodontics and preventive dentistry, alongside a limited representation of the patient within the scientific discourse.
Conclusions: the early development of AI in dentistry was characterized by its consolidation as a support tool aimed at reproducing and validating expert knowledge. This process prioritized technical measurement and standardization, while ethical and patient-centered dimensions remained marginal.

Keywords: Artificial Intelligence; Dentistry; Expert Systems; Bibliometric Analysis; History Of Science.

RESUMEN

Introducción: la integración de la inteligencia artificial en odontología se remonta a finales del siglo XX en un contexto marcado por la informatización de los sistemas de salud. Inicialmente, estos desarrollos se orientaron a reproducir el razonamiento expertto mediante sistemas basados en reglas, particularmente en áreas con criterios clínicos formalizables.
Método: se realizó un estudio cualitativo con enfoque analítico-interpretativo basado en literatura científica publicada entre finales de los años 80 y finales de los 90, complementado con exploración en Scopus y Web of Science hasta el año 2000. Se aplicaron análisis histórico, historiográfico y etnográfico, junto con un análisis bibliométrico de co-ocurrencia de palabras clave mediante VOSviewer.
Resultados: se identificaron tres fases: experimentación institucional, desarrollo de sistemas especializados y validación clínica. La evolución conceptual evidenció un desplazamiento desde la construcción de sistemas hacia su evaluación mediante métricas como precisión y concordancia. El análisis bibliométrico mostró la transición desde "sistemas" y "reglas" hacia términos asociados a validación y desempeño clínico. Se observaron vacíos en áreas como periodoncia y odontología preventiva, así como una limitada presencia del paciente en el discurso científico.
Conclusiones: el desarrollo temprano de la IA en odontología se caracterizó por su consolidación como herramienta de apoyo, orientada a reproducir y validar el conocimiento experto. Este proceso priorizó la medición técnica y la estandarización, dejando en segundo plano dimensiones éticas y centradas en el paciente.

Palabras clave: Inteligencia Artificial; Odontología; Sistemas Expertos; Análisis Bibliométrico; Historia De La Ciencia

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INTRODUCTION

The incorporation of artificial intelligence (AI) into dentistry is not a recent phenomenon, even though its current prominence might suggest otherwise. Since the late 20th century, various attempts to integrate computer systems into clinical practice have begun to shape the field of interaction between dental knowledge and algorithmic logic. These early developments did not emerge in a technological vacuum but rather in a context marked by the growing computerization of healthcare systems and the need to manage ever-increasing volumes of clinical information. In this scenario, AI was initially conceived to organize, reproduce, and assist expert reasoning rather than as a substitute for the professional.

During the early stages, the emphasis was on rule-based systems, designed to capture specialists' knowledge and translate it into formal structures that computers could process. These tools were particularly effective in areas where clinical decisions could be expressed through relatively stable criteria, such as prosthesis design or implant treatment planning. The formalization of knowledge enabled not only the replication of decision-making patterns but also the identification of inconsistencies in everyday clinical practice, highlighting the gap between theoretical consensus and actual implementation.

As the 1990s progressed, a shift in the field's focus began to emerge. Attention shifted from solely building systems to also validating them against clinical and statistical criteria. This change responded, in part, to the need to legitimize these technologies within a profession characterized by high standards of responsibility and diagnostic accuracy. In this context, some studies began comparing the performance of expert systems with that of human specialists, introducing quantitative methodologies to establish equivalences or significant differences.

Moreover, new forms of interaction between professionals and technology emerged. The incorporation of more intuitive interfaces, along with early developments in virtual environments, reflected a growing concern for the user experience and the integration of these tools into daily practice. This shift suggests that the value of AI lies not only in its computational capacity but also in its ability to adapt to existing dentistry workflows.

Despite these advances, the early development of AI in this field presents gaps that invite critical reflection. Some clinical areas, such as periodontics or preventive dentistry, remained on the sidelines of these initial efforts, possibly because of the difficulty of formalizing processes that depend on longitudinal and contextual factors. Similarly, the patient's role appears only faintly in many of these studies, reduced to a dataset or an abstract clinical case, without explicit consideration of their experience or the ethical implications of automated decision-making.

This study aims to examine this formative period in a structured manner, not only from a technological perspective but also by considering the conceptual and cultural frameworks that accompany the introduction of AI in dentistry. Through an analysis that integrates historical, discursive, and social dimensions, the study seeks to understand how the earliest relationships between humans and intelligent systems were shaped in this field and the tensions and limitations that emerged in the process.

METHOD

Study Design

A qualitative study with an analytical-interpretive approach was conducted to examine the evolution of artificial intelligence (AI) in dentistry during its formative stage. The design combined three levels of analysis, historical, historiographical, and ethnographic, to reconstruct not only technological progress but also the discursive and cultural transformations associated with its incorporation into dental practice.

Documentary Corpus

The analysis was based on a set of scientific publications selected for their thematic relevance and temporal representativeness. Studies focusing on artificial intelligence applications in dentistry published between the late 1980s and the late 1990s were included. The inclusion criteria were (i) direct relevance to artificial intelligence applied to the field of dentistry; (ii) the presence of significant methodological, clinical, or conceptual contributions; and (iii) diversity in areas of application, including diagnosis, prosthetic design, treatment planning, and professional evaluation.

In addition, a complementary bibliographic exploration was conducted using the Scopus and Web of Science databases, with the temporal scope extended to 2000. This extension enabled the identification of early traces and initial developments in artificial intelligence in dentistry, providing a broader contextual framework for examining the field's origins and formative patterns.

Studies without a clear application in dentistry or with insufficient methodological information for analysis were excluded.

Analysis Procedure

The selected articles were systematically reviewed. Key elements were extracted from each document, including objectives, methodological approaches, type of AI system used, clinical context, and main results. A comparative reading was subsequently conducted to identify recurring patterns, conceptual breaks, and thematic gaps.

The analysis was structured across three dimensions:

- Historical analysis enables the chronological organization of developments by identifying evolutionary phases and turning points in the application of AI in dentistry.
- Historiographic analysis focuses on the study of scientific language and examines terminological evolution, predominant conceptual frameworks, and forms of knowledge legitimization.
- Ethnographic analysis addressed the relationship between professionals and technologies, considering the role assigned to AI, adoption dynamics, and the representation of the patient within scientific discourse.

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Bibliometric and co-occurrence analysis

To complement the qualitative analysis, a keyword co-occurrence study was conducted using the titles and abstracts of the included articles. For this purpose, the software VOSviewer, which is widely employed in bibliometric studies for visualizing conceptual networks, was used.

The resulting figure (figure 1) is a co-occurrence map that represents the conceptual framework of research on AI applied to dentistry. In this map, each node corresponds to a relevant term identified in the document corpus, and its size reflects its frequency of occurrence. The proximity between nodes and the thickness of the links indicate the strength of association between concepts, measured by the frequency with which they appear together in the analyzed texts.

This procedure allowed us to identify thematic clusters, dominant conceptual relationships, and possible shifts in research lines over time. Based on this visualization, it was possible to recognize a transition from approaches centered on expert systems and knowledge representation toward perspectives focused on clinical validation, data analysis, and diagnostic accuracy.

RESULTS AND DISCUSSION

Chronology and Temporal Milestones

The dataset spans approximately fifteen years of early AI integration in dentistry, from the mid-1980s to the close of the 1990s, a period that corresponds to the broader expansion of computational power in clinical settings. Three distinct phases emerge from the chronological distribution of the articles.

Phase I: Institutional Experimentation (1987–1991)

The earliest documents are dominated by expert systems understood as tools for encoding and reproducing specialist knowledge. Truax and Bailit[1] present perhaps the dataset's first genuine breakthrough moment: a microcomputer-based workstation that integrates an expert system with voice-driven input and financial management, explicitly designed to support "the clinical and financial functions of a small dental practice".

This is an AI conceived as an administrative–clinical hybrid. The 1988 IEEE Proceedings consolidate the institutional context, listing "artificial intelligence and information systems," "neural networks," and "bioengineering in dentistry" as distinct tracks within a single biomedical engineering conference, a sign that these fields were being organized, cataloged, and normalized within the engineering–medicine interface simultaneously.[2] Hieb[3] articulates the era's ambivalence with the title "Challenges and Opportunities for Effective Dental Automation", signaling that the aspiration to automate dental practice was already debated at the level of dental education.

Phase II: Knowledge Engineering and Specialized Systems (1992–1996)

The early 1990s saw a proliferation of domain-specific knowledge-based systems. Benjamin (1992) documents CT-scan-driven CAD/CAM workflows for subperiosteal implants, showing that computational imaging was already producing clinical outcomes: the elimination of the first surgical stage and improved anatomical precision.[4] Van Putten and Yamada (1992) extend the same logic to alloplastic cranial implants, demonstrating that AI-assisted design could reduce surgical time and postsurgical complications.[5]

Two papers by Hammond, Davenport, and Fitzpatrick mark a significant methodological moment: they develop RaPiD, a "design assistant" for removable partial dentures that encode expert design rules in first-order predicate logic and apply them as integrity constraints, moving the field from informal heuristics to formal knowledge representation.[6,7] By 1995, Zhang et al. introduced AI into professional credentialing in medicine and dentistry, with a system of 536 000 questions that adjusts passing scores algorithmically, a distinctly different application that treats AI as a quality-assurance mechanism for human practitioners rather than a diagnostic tool per se.[8]

Phase III: Clinical Validation and Interface Refinement (1996–1999)

In the late 1990s, attention shifted toward validation and usability. Firriolo and Levy (1996) submit their salivary gland diagnostic expert system to a rigorous kappa analysis and compare it with that of four oral pathologists; the system shows "no significant difference in diagnostic performance between the system and the human experts."[9]

This is a genuine breakthrough in validation methodology, the first paper in the dataset to directly benchmark AI against human specialists using statistical inference. Snow, Graham, and Yates[10] and Herder et al.[11] introduce virtual reality as an interface layer for intelligent dental systems, reflecting a shift in concern from what AI systems "know" to how dentists "interact" with them. Poon and Freer[12] presented EICO-1, the first expert system in dentistry, to use the Ripple-Down-Rules methodology, allowing the orthodontist to maintain the knowledge base without a knowledge engineer, a landmark democratization of AI maintenance.[12]

Clinical Problems as Historical Drivers

The dataset reveals a clear hierarchy of clinical motivations. Prosthetic design (removable partial dentures, cranial implants) is the single most persistent application area across the entire period, driven by the tractability of design rules to formal representation. Diagnostic imaging, from the RVG-ui sensor's AI module for caries detection[13] to CT-based implantology[4], constitutes the second major strand. Oncological screening appears late but forcefully: Downer, Jullien, and Speight[14] use AI to preselect high-risk individuals for oral cancer screening, demonstrating that AI could reduce examination burden by 75 % while saving "two to three times" more lives than nonselective screening does. Treatment planning, orthodontics, and histopathology each generate one significant paper. Preventive dentistry, periodontics, endodontics, and pediatric dentistry are conspicuously absent, a silence

addressed below.

The Evolution of Language

The linguistic register of the dataset shifts markedly across the three phases identified above, and the shift tracks a wider pattern in science and technology studies: from promissory discourse to performative demonstration.

In the late 1980s, the language was declarative and infrastructural. Truax and Bailit[1] note that their expert system is "undergoing clinical tests" and that "additional knowledge bases are under development", a future-oriented syntax that positions the system as a prototype whose value is to be determined. Hieb[3] frames dental automation as a set of "challenges and opportunities," adopting the policy-report register of aspirational technology discourse.

By the early-to-mid 1990s, language became more architecturally precise. Hammond et al.[7] write "logic-based integrity constraints," "first-order predicate logic," and "a logic database of design components", the vocabulary of formal computer science rather than clinical practice. Davenport, Hammond, and Fitzpatrick[6] describe their system as "a powerful tool for improving this aspect of dental care," still instrumental but now confident in the direction.

By the late 1990s, the language had migrated toward clinical and epidemiological validation. Downer et al.[14] work in the register of public health economics, QALYs, equivalent lives saved, and cost of examination per case detected and describe AI not as a computational innovation but as a "promising health promotion strategy" that "should be subject to formal economic appraisal". Firriolo and Levy[9] adopt the vocabulary of inferential statistics (weighted kappa, Wilcoxon rank sums, Fisher's exact test, Turing's test), subordinating AI identity to its measurable equivalence with human expertise. Poon and Freer[12] describe EICO-1 as an "interactive advisory tool" applicable "in a clinical situation", language that foregrounds usability rather than technical novelty.

Walther[15] captures the decade's linguistic trajectory in a single sentence: "The most advanced form of data application is the expert system, which is able to carry out case comparisons and draw model-based conclusions on the basis of empirical knowledge." The expert system has been normalized as the apex of a data management continuum rather than celebrated as a radical rupture.

Keyword Dominance: Early vs. Late

Early papers (1987–1992) cluster around "expert system", "knowledge base", "workstation", "rule-based", "clinical decision support", "CAD/CAM", and "CT scan". These terms belong to knowledge engineering and its adjacent hardware vocabulary. Neural networks appeared in the 1988 IEEE Proceedings as a category alongside AI, but no paper in the dataset was specifically devoted to neural network methodology until Robertson, Sillén, and Norén[16], who tested a neural network as a first-pass pattern detector in trauma questionnaire analysis before moving to inductive rule extraction, notably describing the neural network as unable to "make relations explicit." This is a telling historiographical moment: neural networks are acknowledged and then immediately subordinated to more interpretable inductive methods, reflecting the era's preference for explainability over raw predictive performance.

By the mid-to-late 1990s, the dominant keyword cluster shifted toward "validation", "knowledge acquisition", "virtual reality", "QALYs", "screening", "inductive analysis", and "Bayesian classification". The appearance of "virtual reality" in both Snow et al. [10] and Herder et al.[11] suggests that the field was beginning to consider AI not just as a reasoning engine but as an experiential environment for both clinicians and, prospectively, patients.

Silences in the Dataset

Several clinical territories are absent from the AI narrative in these documents. Periodontics, the subspecialty most dependent on longitudinal patient monitoring and arguably the area where pattern recognition might offer the greatest diagnostic gain, is completely unrepresented. Endodontics, despite its heavy reliance on radiographic interpretation, exactly the kind of task where AI showed early promise in caries detection, is also absent. Pediatric dentistry and preventive care, despite their population-health implications, generate no dedicated study. General practice AI integration at the workflow level (appointment scheduling, billing optimization, patient communication) appears only in the earliest paper (Truax & Bailit, 1987) and is not revisited. Ethics, patient consent, liability, and the professional-legal implications of algorithmic decision support are entirely absent from the dataset, a silence that is, from the vantage of the 2020s, both striking and historically revealing.

Ethnographic perspective: Human Factor and Culture

The Human–Machine Relationship

Across the full dataset, AI is consistently positioned as a "support tool" for the dentist, never as an autonomous agent. The terminological choices are deliberate and revealing: Truax and Bailit[1] call it an "expert-system-enhanced" workstation; the workstation belongs to the dentist, and the AI merely enhances it. Hammond et al.[7] explicitly describe RaPiD as a "design assistant," a term that grammatically subordinates the system to the practitioner. Poon and Freer[12] call EICO-1 an "interactive advisory tool". Herder et al.[11] designed their VR interface specifically to bridge "the cognitive gap between the dentist and the computer system" using metaphors drawn from dentistry's existing tool culture, preserving the dentist's cognitive sovereignty.

One partial exception is that of Firriolo and Levy[9], where the expert system is shown to perform statistically equivalently to four oral pathologists. However, even here, the framing is diagnostic equivalence rather than replacement: the system is described as demonstrating "the validity of histopathological diagnostic expert systems in a selected area of oral pathology," not as obviating the need for pathologists.

This consistent framing of AI-as-assistant reflects a professional culture in which the dentist's epistemic authority is structurally nonnegotiable. AI is introduced as a technology that amplifies that authority and stores, processes, and returns expert knowledge

rather than one that competes with it.

Patient in the Research Frame

The patient is almost entirely absent as a subject in this dataset. When patients appear, they appear as data sources, risk objects, or beneficiaries of efficiency. Downer et al.[14] construct their entire analysis around a "notional population of 100,000 adults", and statistical abstractions whose QALY gain is calculated but whose experience of being screened, classified, and risk-stratified by an algorithm is never considered. Robertson et al.[16] analyze questionnaires completed by patients after dental trauma, but the patients themselves are voices encoded into variables to be processed by inductive algorithms. Walther[15] describes the path from "patient data records" to "the basis of knowledge"; the patient's record migrates into a system's knowledge base, and the patient's identity dissolves into evidence.

Only Zhang et al.[8] inverted this structure: their AI system positions the "dental professional" as the examination subject, assessed and credentialed by a machine, a curious reversal in which the practitioner occupies the position ordinarily reserved for the patient.

The patient's body is addressed instrumentally throughout: the RVG-UI[13] values reduce the radiation dose and accelerate image acquisition as improvements that benefit the patient, but the benefit is framed as a byproduct of imaging efficiency rather than as a primary ethical commitment.

Values Underlying Technological Adoption

Three value clusters are visible across the corpus

"Precision and clinical equivalence" dominate the papers most directly engaged with diagnostic tasks.[9,16] The goal is for AI to match, and thereby legitimize itself against, human expert performance. Precision here has both a technical meaning (diagnostic accuracy) and a professional meaning (preservation of the epistemic standards of clinical specialization).

"Efficiency and resource rationalization" are the dominant values in public health and implantology papers. Benjamin[4] emphasized the elimination of a surgical stage and a reduction in complications. Downer et al.[14] frame AI's value in terms of QALYs per examination and lives saved per screened population, the moral language of health economics. Zhang et al.[8] celebrate a system costing less than $46,000 USD that examined more than 125,000 candidates in six years, foregrounding cost-effectiveness as a primary virtue.

"Standardization and knowledge democratization" underlie the prosthetic design papers. Davenport et al.[6] note that "dentists frequently fail to provide dental technicians with the design information necessary for the construction of removable partial dentures" and propose their system as a remedy for this professional communication failure. Poon et al.[12] design EICO-1 so that it can be maintained "without the help of knowledge engineers", making advanced AI accessible to a single practitioner.

Davenport et al.[17] surveyed all 17 British dental schools and reported an 89 % consensus on design rules and then encoded that consensus into a system, transforming collegial agreement into algorithmic authority.

Analysis of Cluster Structures: The Architecture of Knowledge

Analysis of the data extracted from the studies (figure 1) allowed us to identify different clusters that function as "niches of thought."

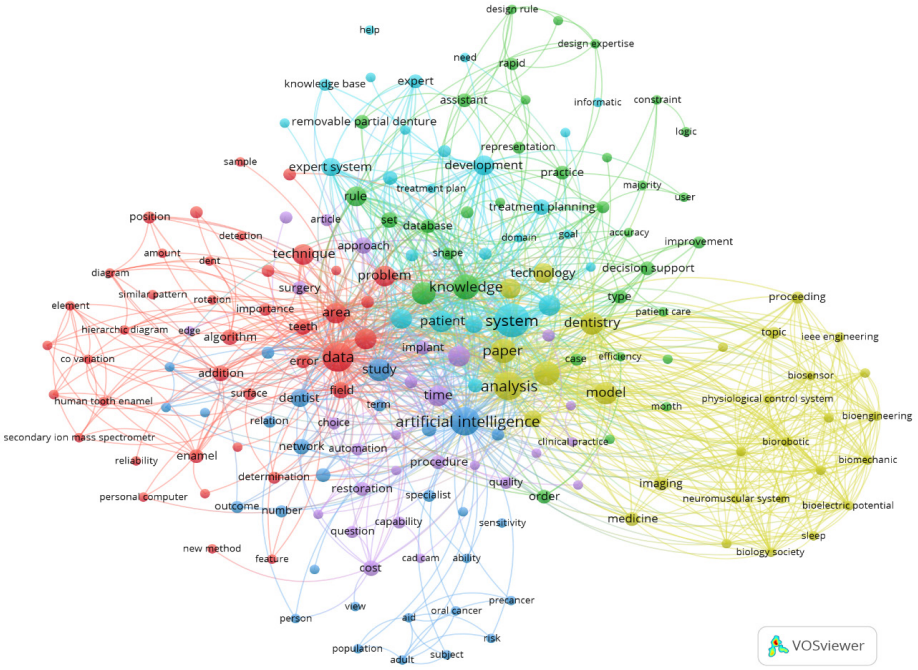


Figure 1. Bibliometric co-occurrence map of keywords in the literature on artificial intelligence in dentistry

Below, we breakdown the main groups and their significance:

The Technical and Systemic Core Cluster

At the center of the network, we observe nodes such as "system" and "algorithm". Historically, these nodes represent the foundational phase. In the 1990s, the dental literature did not discuss "deep learning" or "neural networks" (terms that would come later) but rather "systems."

This is the era of "technological promise." The discourse focused on system architecture as a self-sufficient entity. AI was conceptualized as an "expert system" that emulated clinical reasoning. The use of the term "system" denotes an instrumental vision: AI was a container of logical rules.

Clinical Validation Cluster

Cluster 2, dominated by terms such as "accuracy", "agreement", and "sensitivity/specificity", represents the shift toward evidence-based medicine. This is where AI ceases to be a theoretical "black box" and becomes an object of clinical measurement.

This cluster reveals that, in the mid-1990s, the historiography of AI in dentistry began to be dominated by statistical methodology. The question was no longer "Can the machine think?" but "How close does the machine come to the human dentist's diagnosis?" This marked a critical transition: AI is subjected to the validation standards of traditional clinical dentistry (sensitivity and specificity).

Practical application and patient cluster

Cluster 3, with terms such as "adult", "aid", and "ability", suggests a concern for immediate applicability. On the other hand, terms such as "surgery" link AI to interventional procedures.

These nodes indicate that the AI sought to integrate rapidly into the areas with the highest workload and greatest risk (surgery and adult diagnosis). This was not basic research but applied research intended to "aid" the clinical workflow.

The Evolution of the Discourse

This bibliometric analysis reveals a clear evolutionary timeline:

- 1990–1993 (Conceptualization Phase): concepts such as "ability" (1990.5) and "system" (1993.75) dominate. The language is broad and almost philosophical. Dentistry sought to understand what "abilities" the machine could contribute.
- 1994–1995 (Engineering and Implementation Phase): Concepts such as "surgery" (1994.5), "algorithm" (1994.8), and "study" (1995) show maturation toward implementation. AI moves from theory to methodological articles.
- 1996–1997 (Standardization Phase): The emergence of "accuracy," "agreement," "adult," and "aid" (all occurring between May 1995 and May 1996) marks the turning point. AI becomes standardized. It is no longer a novelty; it is a measurable entity that must prove its reliability through agreement with human judgment.

Ethnographic Perspective

Analysis of these data allows us to make an ethnographic inference about how the literature "imagines" the dentist.

The recurring use of the keyword "aid" is deeply revealing. In the literature, AI is not presented as an entity that transforms the profession but as a tool that serves as an aid. This reflects a defensive stance of professional dental culture: AI "helps," but the dentist retains agency. The machine is an "aid," not a "partner."

The prevalence of terms such as "adult" and the absence of terms related to the patient's experience, comfort, or perception (the patient's "ethnography") is notable. The patient appears in the literature not as a social actor but as a test subject for the algorithm. AI in dentistry has been constructed, according to this network, as a technology that optimizes the dentist–diagnosis relationship but renders the patient invisible as a biopsychosocial being.

The obsession with "accuracy" and "sensitivity" reveals a professional culture that values technicality over narrative. Within this framework, AI is a means to achieve scientific objectivity that the (fallible) human eye cannot achieve on its own. Historically, dentists have been trained to trust their technical intuition; the AI literature seems to seek to replace that intuition with a quantifiable metric.

Discussion of "Historiographic Silences"

A fundamental part of any historiographic analysis is identifying what *is not* on the map.

1. Absence of Ethics and Bias: In the analyzed clusters (as per the data in AIHist.txt), no nodes related to "ethics," "bias," "privacy," or "transparency" appear. This suggests that the historiography of AI in dentistry was, during this period, purely technical and technocratic. There was no reflection on the risks of algorithmic opacity.
2. "Black box" as the standard: The literature shows a strong interconnection between 'algorithm' and "accuracy," but there are no strong links to the "explainability" of the system. This implies a culture where results (accuracy) matter more than the reasoning process (explainability).
3. Lack of Interdisciplinarity: The map shows a dense concentration of technical and biomedical terms but few nodes involving social sciences, pedagogy, or communication. Dental AI has developed in isolation, without dialog with medical humanities.

Final bibliometric considerations

The analyzed bibliometric network is not merely a representation of publications; it is the digital footprint of epistemological evolution. We have documented how AI evolved from being a "theoretical capability" to becoming a "precision measurement system."

The "footprints" or foundations left by this literature are clear:

1. Foundation in Validation: The main foundation is not algorithmic creativity but clinical validation. AI has become a part of dentistry to the extent that it can match or surpass the accuracy of traditional human diagnosis.
2. Clinical Reductionism: There is a historiographical tendency to reduce medical acts (complex, relational) to a task of image classification (sensitivity/specificity). This reductionism is the pillar upon which the current "fever" for AI in modern dentistry rests.
3. Technical dehumanization: AI has been constructed as a technology that optimizes 'doing' (diagnosing, operating) but ignores "being" (interaction with the patient, the ethics of care).

For future research, the discipline must move beyond "precision" and begin to explore nodes that are currently absent from this map, such as equity, algorithmic explainability, and patient-centered experience. According to our network, the history of AI in dentistry is a story of technical success but of humanistic debt.

Study Limitations

The approach adopted acknowledges the limitations inherent in the qualitative analysis of historical literature, particularly regarding the selection of the corpus and the interpretation of scientific discourses. Similarly, bibliometric analysis is conditioned by the quality and consistency of the terms used in the original articles, which may influence the representation of conceptual relationships.

Nevertheless, the combination of qualitative methods and visualization tools enabled the development of a comprehensive approach to the early development of AI in dentistry, linking documentary evidence with interpretive frameworks that capture both the technical evolution and the intellectual dynamics of the field.

CONCLUSION

What this corpus of fifteen years of early AI in dentistry leaves behind is less a history of technological breakthroughs than a cultural history of professional boundary work. The documents collectively construct AI in dentistry as legitimate (through statistical validation against human experts), safe (as an assistant rather than an autonomous agent), efficient (measured in QALYs, surgical stages eliminated, and examination costs), and reproducible (by encoding consensus expert knowledge into rule systems that can be maintained by practitioners themselves).

The patient never speaks. The dentist's authority is never displaced and is only extended. Ethics is deferred. Neural networks appear briefly and are quickly resubordinated to interpretable rule systems, a choice that reflects not only the computational limitations of the era but also a professional culture that values explicability and accountability in clinical reasoning. The dominant institutional locations, IEEE conferences, prosthetic dentistry journals, Australian orthodontics, and British dental schools reveal a geography of early adoption concentrated in engineering-adjacent biomedical communities and in elite specialty training contexts.

The silence around preventive dentistry, periodontics, and patient experience is not incidental. It reflects where AI was and was not legible to existing professional frameworks: tractable where problems could be formalized as rules or measured as images and absent where clinical judgment was relational, longitudinal, or patient centered. These are the architectural constraints, epistemological as much as technical, that subsequent generations of dental AI researchers would either inherit or, eventually, begin to dismantle.

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CONFLICT OF INTEREST

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AUTHORSHIP CONTRIBUTION

Conceptualization: Marta González Herrera, Jany Murguia Martínez, Felipe Andrade Santos.
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