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CONTRIBUIÇÕES E LIMITAÇÕES DA INTELIGÊNCIA ARTIFICIAL NO PLANEJAMENTO DIGITAL DE RESTAURAÇÕES ESTÉTICAS EM DENTES ANTERIORES: UMA REVISÃO DA LITERATURA

CONTRIBUTIONS AND LIMITATIONS OF ARTIFICIAL INTELLIGENCE IN THE DIGITAL PLANNING OF ESTHETIC RESTORATIONS IN ANTERIOR TEETH: A LITERATURE REVIEW

CONTRIBUCIONES Y LIMITACIONES DE LA INTELIGENCIA ARTIFICIAL EN LA PLANIFICACIÓN DIGITAL DE RESTAURACIONES ESTÉTICAS EN DIENTES ANTERIORES: UNA REVISIÓN DE LA LITERATURA

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RESUMO: Este estudo teve como objetivo revisar a literatura sobre as contribuições e limitações da inteligência artificial (IA) no planejamento digital de restaurações estéticas em dentes anteriores. Foi realizada uma busca nas bases de dados PubMed e Scopus, utilizando descritores relacionados à inteligência artificial, ao planejamento digital do sorriso e à estética dentária. Foram incluídos estudos publicados em inglês, disponíveis na íntegra e relacionados ao planejamento estético. Dos 132 artigos identificados, sete estudos publicados entre 2024 e 2026 atenderam aos critérios de elegibilidade. Os resultados demonstraram que a IA apresenta potencial para auxiliar na análise da simetria facial, na definição das proporções dentárias, na simulação de resultados estéticos e na redução do tempo de planejamento. Entretanto, foram identificadas limitações importantes, principalmente a predominância de desfechos subjetivos, como satisfação e preferência estética, e a ausência de avaliações sistemáticas que comparem os resultados planejados com aqueles clinicamente alcançados. Além disso, nenhum estudo abordou especificamente o planejamento de restaurações diretas em resina composta. Conclui-se que, embora promissora, a aplicação da IA nessa área ainda necessita de estudos clínicos que comprovem sua aplicabilidade e eficácia na prática restauradora direta.

Palavras-chave: Inteligência Artificial. Estética Dentária. Planejamento Digital.

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ABSTRACT: This study aimed to review the literature on the contributions and limitations of artificial intelligence (AI) in the digital planning of esthetic restorations in anterior teeth. A search was conducted in the PubMed and Scopus databases using descriptors related to artificial intelligence, digital smile planning, and dental esthetics. Studies published in English, available in full text, and addressing esthetic planning were included. Of the 132 articles identified, seven studies published between 2024 and 2026 met the eligibility criteria. The results demonstrated that AI has the potential to assist in facial symmetry analysis, determination of dental proportions, simulation of esthetic outcomes, and reduction of planning time. However, important limitations were identified, particularly the predominance of subjective outcomes, such as esthetic satisfaction and preference, and the lack of systematic assessments comparing planned outcomes with clinically achieved results. Furthermore, none of the studies specifically addressed the planning of direct composite resin restorations. It was concluded that, although promising, the application of AI in this field still requires clinical studies to establish its applicability and effectiveness in direct restorative practice.

Keywords: Artificial Intelligence. Dental Esthetics. Digital Planning.

RESUMEN: Este estudio tuvo como objetivo revisar la literatura sobre las contribuciones y limitaciones de la inteligencia artificial (IA) en la planificación digital de restauraciones estéticas en dientes anteriores. Se realizó una búsqueda en las bases de datos PubMed y Scopus, utilizando descriptores relacionados con inteligencia artificial, planificación digital de la sonrisa y estética dental. Se incluyeron estudios publicados en inglés, disponibles en texto completo y relacionados con la planificación estética. De los 132 artículos identificados, siete estudios publicados entre 2024 y 2026 cumplieron los criterios de elegibilidad. Los resultados demostraron que la IA presenta potencial para contribuir al análisis de la simetría facial, la determinación de las proporciones dentales, la simulación de resultados estéticos y la reducción del tiempo de planificación. Sin embargo, se identificaron limitaciones importantes, principalmente el predominio de resultados subjetivos, como la satisfacción y la preferencia estética, y la ausencia de evaluaciones sistemáticas que comparen los resultados planificados con los obtenidos clínicamente. Además, ningún estudio abordó específicamente la planificación de restauraciones directas con resina compuesta. Se concluye que, aunque prometedora, la aplicación de la IA en este campo requiere estudios clínicos adicionales que demuestren su aplicabilidad y eficacia en la práctica restauradora directa.

Palabras clave: Inteligencia Artificial. Estética Dental. Planificación Digital.

INTRODUCTION

Dental esthetics are among the main motivations that drive patients to seek dental care. In this scenario, composite resin has gained prominence, since the constant development of its technology over the last decades has made the material the first choice for the restoration of anterior and posterior teeth (Demarco *et al.*, 2015). The high esthetic standards demanded by patients have driven this evolution of the material, even though there are failures characteristic of the composite, such as polymerization shrinkage, microleakage, and loss of adhesion to the tooth structure (Silva *et al.*, 2023).

In the anterior region, the direct restorative technique with composite resin combines favorable attributes, such as the preservation of sound tooth structure, single-session resolution, relative reversibility, and affordable cost when compared to the indirect technique. A systematic review (Demarco *et al.*, 2015) that evaluated the survival of anterior composite resin restorations, with a minimum follow-up of three years, including Class III and IV cavity restorations, direct veneers, and coronal reconstructions, observed satisfactory clinical performance of the material, showing that composite restorations can present adequate longevity in anterior teeth. However, their durability does not depend exclusively on the material employed, being influenced by factors related to the patient, the operator, and the characteristics of the restoration.

The success of these rehabilitations does not depend exclusively on the properties of the material, but also on adequate planning and on the prior definition of the desired result. This stage is fundamental, since alterations in the morphology of the anterior teeth can directly influence the harmony of the smile and the final appearance of the patient (Chisnoiu *et al.*, 2023). In this context, the diagnostic wax-up has been consolidated as a fundamental tool in planning, contributing to greater treatment predictability. The transfer of this planning to the oral cavity, by means of the *mock-up*, allows the proposed result to be evaluated beforehand and possible discrepancies between the planning on the model and its clinical application to be identified (Simon; Magne, 2008). In addition, it plays an important role in communication between the dentist, the patient, and the technician, favoring the understanding of the planning and the acceptance of the proposed treatment (Garcia *et al.*, 2018).

Traditionally used in restorative planning, the analog workflow presents limitations related to predictability and to the visualization of the result. The execution of conventional impressions and wax-ups can hinder the communication of the planning to the patient and make the process more dependent on the experience and skill of the professional (Alwabel *et al.*, 2025). In this context, the digital workflow emerges as an alternative capable of improving the predictability of planning, reducing the influence of operator-related factors, and facilitating the visualization of the proposed result (Cattoni *et al.*, 2019).

Digital dentistry emerged as an alternative to the limitations of the analog workflow, incorporating resources that expand the predictability and the visualization capacity of the treatment. Intraoral scanning allows conventional impressions to be replaced, presenting equivalent or superior results in single-unit restorations and enabling their integration with CAD/CAM systems, which favors communication with the laboratory (Baradee; Spies, 2025). Furthermore, the possibility of visualizing and simulating the result three-dimensionally from different perspectives allows the proposed alterations to be evaluated in advance, contributing to the diagnosis and to a planning that is more faithful to the expected result (Tallarico, 2020).

In this context, Digital Smile Design (DSD) has been consolidated, integrating photographs, scanning, and computer-assisted analysis. Recent evidence indicates that this approach can improve patient satisfaction and acceptance, in addition to favoring greater treatment predictability when compared to conventional methods (Alwabel *et al.*, 2025). However, despite the advances provided by DSD, its use may still involve laborious steps that demand time and technical knowledge from the professional. In this scenario, artificial intelligence (AI) emerges as a complementary tool, with the potential to optimize and automate certain stages of esthetic planning. Through the analysis of large volumes of data and the recognition of patterns related to dental proportion and facial harmony, AI-based systems can assist in the definition of the smile design and reduce the time required for planning (Kaushik *et al.*, 2025). Beyond planning, different applications of AI have been described in restorative dentistry, including shade selection, the detection of preparation margins, and the generation of tooth morphology (Tabatabaian *et al.*, 2023).

Given the growing use of artificial intelligence as a support tool for esthetic planning, the present study aims to analyze its contributions and limitations in the digital planning of

esthetic restorations in anterior teeth, discussing the implications of these findings for the planning of direct composite resin restorations by means of a literature review.

METHODOLOGY

2.1 Article search strategy

This is an integrative literature review, conducted based on the following guiding question: "What are the contributions and limitations of artificial intelligence in the digital planning of esthetic restorations in anterior teeth?". The bibliographic search was carried out in the PubMed and Scopus databases, from August 20 to 22, 2026.

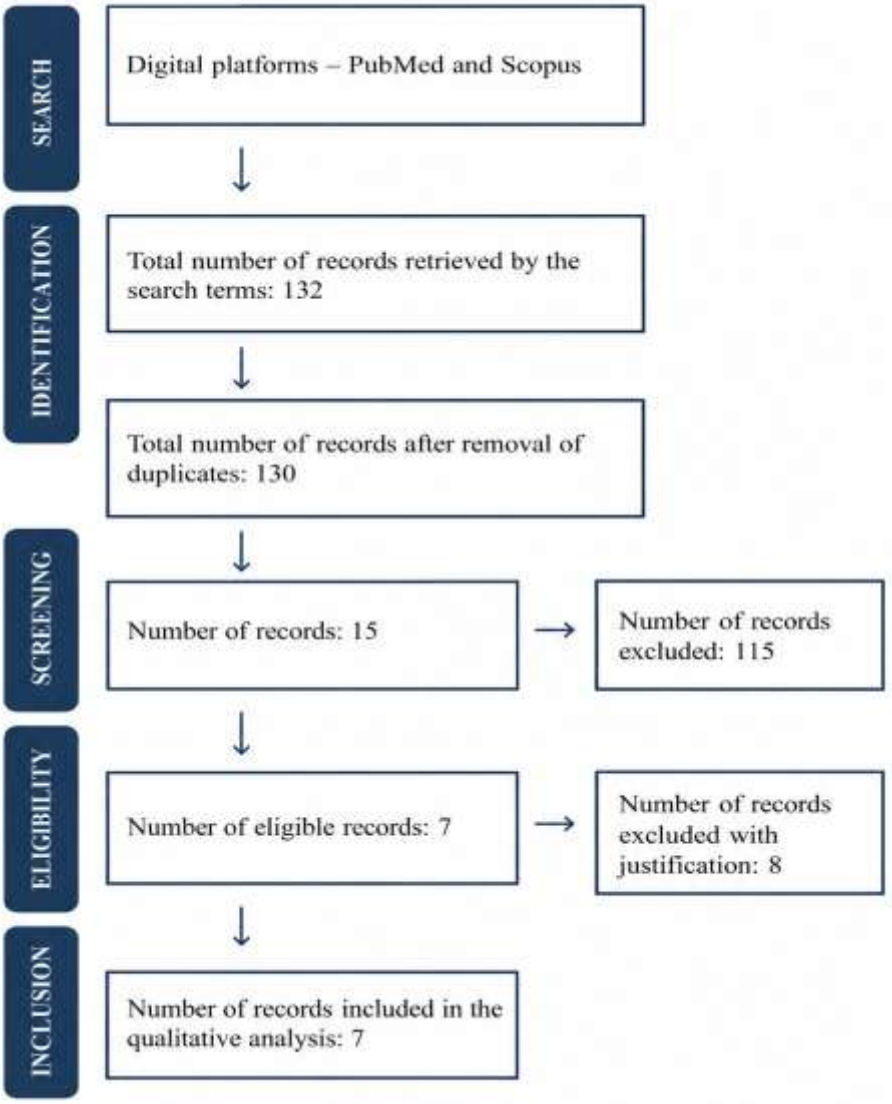
For the development of the search strategy, descriptors related to the concepts of artificial intelligence, esthetic planning, and anterior teeth were used, as well as their corresponding terms in English. Considering the absence of an exact correspondence for some terms in the controlled vocabulary and the diversity of nomenclatures employed in literature, terms related to each concept were incorporated. The terms "deep learning" and "machine learning" were associated with the first set; "smile design", "esthetic planning", and "treatment planning" with the second; and "esthetic dentistry" and "anterior teeth" with the third. The terms belonging to each set were combined using the Boolean operator OR, while the three conceptual sets were associated using the operator AND, to broaden the scope of the search while simultaneously maintaining its relationship with the proposed topic.

The following inclusion criteria were established: articles published between 2019 and 2026, in English, with full text available, and addressing the use of artificial intelligence in the planning of esthetic cases in anterior teeth. Studies related to other areas of dentistry were excluded, as well as those without access to the full text.

2.2 Study selection

The search performed in the PubMed and Scopus databases identified 132 articles. After the removal of duplicates and the application of the eligibility criteria, seven studies were selected to compose the present review. The process of identification, screening, and selection of the studies is presented in Figure 1.

Figure 1 – Flowchart of the identification, screening, and selection of studies.



Source: (LIBARDI LBM, *et al.*, 2026)

RESULTS AND DISCUSSION

The literature search resulted in the inclusion of seven studies published between 2024 and 2026, which investigated different applications of artificial intelligence in esthetic dental planning. The main characteristics of these studies, including authors, study design, objectives,

and principal findings, are summarized in Table 1 (Almohareb *et al.*, 2026; Arjumand, 2024; Binvignat *et al.*, 2025; Mohsin *et al.*, 2025; Rokhshad *et al.*, 2024; Saini *et al.*, 2025; Song *et al.*, 2026).

Table 1 – Summary of the included studies.

Article title/authors	Year	Objective	Main findings	Conclusion
Artificial intelligence and smile design: an e-Delphi consensus statement of ethical challenges. Rokhshad R. *et al.*	2024	To establish consensus among experts on the ethical challenges of using AI in smile design	An international consortium of experts applied an e-Delphi protocol on 11 ITU/WHO ethical principles. In the first round, consensus was reached on seven principles; equity, responsibility, solidarity, and respect for autonomy were rejected and reformulated, reaching consensus in the second round	The development and implementation of AI for smile design must comply with the eleven established ethical principles
The application of artificial intelligence in restorative dentistry: a narrative review of current research. Arjumand B. *et al*	2024	To analyze the influence of artificial intelligence in restorative dentistry, including diagnosis, treatment planning, image analysis, and prosthodontics	Narrative review of 34 studies; AI is described as a tool for analyzing facial symmetry and the individual characteristics of the patient, assisting in the development of personalized plans that address tooth shade and alignment. The ability to simulate and predict esthetic outcomes through 3D modeling is highlighted as transformative, as it allows the patient and the dentist to visualize the result prior to the procedure	The integration of AI into restorative dentistry represents an advance in patient care, but requires attention to data privacy, professional training, and ethical standards
AI in learning anatomy and restoring central incisors: a comparative study. Binvignat P. *et al.*	2025	Comparing the performance of two artificial intelligence approaches in learning and reconstructing the anatomy of maxillary central incisors	STL files of intact permanent maxillary incisors, obtained from three universities, were used to train PCA and DeepSDF models, with three-fold cross-validation. DeepSDF showed significantly higher accuracy than PCA in the surface, volume, and Hausdorff distance metrics. Smaller latent codes in DeepSDF resulted in inferior performance. DeepSDF raised concerns regarding model explainability	Both approaches demonstrate potential for the reconstruction of central incisor anatomy, with an advantage for DeepSDF; future research should improve model explainability and consider broader smile design factors
Development of AI-enhanced smile design software for ultra-personalized esthetic outcomes. Mohsin L. *et al.*	2025	To develop and evaluate a prototype of AI-based smile design software, comparing it	Prototype developed with convolutional neural networks for facial analysis and generative adversarial networks for the creation of the designs, tested on 50 participants. Patient satisfaction of 9.2/10 versus 7.5/10 with the conventional	The AI-based software represents a superior alternative to conventional

Article title/authors	Year	Objective	Main findings	Conclusion
		with conventional methods	method; esthetic quality rated by experts at 8.8/10 versus 7.3/10; 40% reduction in planning time	methods, with greater satisfaction, efficiency, and esthetic accuracy
Impact of artificial intelligence-based digital smile design on patient and clinician satisfaction and facial esthetic outcomes: a systematic review and meta-analysis. Saini RS. *et al.*	2025	To evaluate the influence of AI-generated Digital Smile Design on patient and professional satisfaction and on facial esthetic outcomes	Search in PubMed, Scopus, Cochrane, ScienceDirect, and Google Scholar (2004–2024); seven studies included after screening 387 records. Tools such as SmileCloud, REBEL, and Invisalign SmileView improved smile symmetry, lip arcs, and incisal edge visibility. The meta-analysis indicated a pooled satisfaction prevalence of 58% (95% CI: 0.30–0.86), with high heterogeneity (I^2 = 60.23%). The studies presented a moderate risk of bias, with publication bias detected	AI-generated DSD provides significant facial esthetic improvements, but future studies should investigate the long-term sustainability of the results and the cost-benefit ratio
Clinical and patient comparison of AI and expert digital smile design: a prospective paired study. Almohareb T. *et al.*	2026	To objectively compare the esthetic performance of smile designs generated by AI and by an experienced clinician	Prospective paired study with 33 patients; for each case, one design generated by an automated system (SmileFy) and another manually developed in Exocad. Twenty blinded prosthodontists evaluated the designs using the DESI and a VAS. AI-generated designs obtained significantly better DESI scores (14.79 ± 1.63 vs. 18.73 ± 1.82; $p < 0.001$) in the DESI, lower values indicate better performance. VAS ratings by experts and patients were higher for AI ($p < 0.001$), and 69.7% of the patients preferred the AI-generated designs. Mean planning time was 30.82 ± 5.14 min versus 63.48 ± 14.12 min, a reduction of 51.46% ($p < 0.001$)	AI-generated designs showed favorable esthetic performance, greater patient acceptance, and a substantial gain in efficiency, reinforcing their potential as an auxiliary tool in esthetic planning
Motion-DSD: AI-assisted dynamic frontal facial simulation of digital diagnostic waxing from 2-dimensional intraoral digital smile design. Song S. *et al.*	2026	To develop and validate the clinical feasibility of an AI-assisted workflow that transfers the intraoral smile design to a frontal facial video, enabling two-dimensional dynamic simulation of the digital	Two Segment Anything Model networks were fine-tuned with LoRA modules using 2,000 facial images and 190 intraoral images. Segmentation achieved a mean Dice coefficient of 0.886 in the facial set and 0.969 in the intraoral set, with higher accuracy for the central incisors and a progressive decrease toward the canines. An affine transformation algorithm, supported by a standardized facial image, transferred the intraoral design to the facial video, allowing simulation under different expressions. A web interface enables interactive adjustment and real-time preview. Clinical validation was qualitative, with a single participant	Motion-DSD enables two-dimensional simulation of the diagnostic wax-up in a dynamic facial context, anticipating the dynamic assessment to before the physical mock-up stage; further investigations are needed to quantitatively

Article title/authors	Year	Objective	Main findings	Conclusion
		diagnostic wax-up		validate the accuracy of the simulation

Source: (LIBARDI LBM, *et al.*, 2026)

Abbreviations - AI: artificial intelligence; DSD: Digital Smile Design; DESI: Dental Esthetic Screening Index; VAS: visual analog scale; CI: confidence interval; PCA: principal component analysis; STL: stereolithography file.

3.1 Contributions of artificial intelligence to esthetic planning

The use of artificial intelligence (AI) in esthetic planning has been investigated at different stages of dental care, from the automated recognition of facial and dental structures to the elaboration and simulation of the smile design. Arjumand (2024) described AI as a tool capable of analyzing facial symmetry and the individual characteristics of the patient, assisting in the elaboration of plans that consider aspects such as tooth shade and alignment, in addition to enabling the simulation of the result prior to the procedure. However, the statements related to esthetic outcomes presented by the author should be interpreted with caution, since they were not accompanied by specific evidence to support them.

The ability of AI to reproduce anatomical characteristics of the anterior teeth was investigated in two studies. Song *et al.* (2026) developed an automated workflow capable of recognizing facial structures and maxillary anterior teeth, presenting greater accuracy in the identification of the central incisors. As its main contribution, the method enabled the transfer of the design made on the intraoral photograph to a video of the patient's face, allowing the simulation of the smile in motion and expanding the visualization of the planned result. Complementarily, Binvignat *et al.* (2025) compared two methods for the reconstruction of the anatomy of maxillary central incisors and observed greater accuracy of the deep learning-based method in the measurements of surface, volume, and distance between shapes. This study stands out as the only one among the analyzed works to evaluate the performance of AI by means of objective geometric measurements, without relying exclusively on the subjective assessment of examiners.

In addition to the capacity for anatomical reproduction, three studies compared plans developed with the aid of AI to those developed by experienced professionals. Almohareb *et al.*

(2026) presented the most consistent design among the evaluated studies: 33 patients received two plans, one developed in an automated manner and the other by an experienced clinician, subsequently evaluated by 20 specialists who were unaware of the origin of the designs. The automated plan showed better performance in the esthetic index, with a mean of 14.79 points, compared to 18.73 points for the conventional plan ($p < 0.001$), considering that lower scores indicate better performance. Furthermore, approximately 70% of the patients expressed a preference for the automated plan. Similar results were observed by Mohsin *et al.* (2025), who reported greater satisfaction with the AI-based plan, with a mean of 9.2 points, compared to 7.5 points for the conventional method. In a review that gathered seven studies, Saini *et al.* (2025) also identified favorable results related to smile symmetry, lip arc design, and incisal edge exposure.

Another recurrent finding in the studies was the reduction in the time required for planning. Almohareb *et al.* (2026) observed that the automated planning required approximately 30 minutes, while the workflow conducted by the clinician exceeded 60 minutes. Similarly, Mohsin *et al.* (2025) reported a reduction of approximately 40% in planning time with the use of AI. These results suggest that, in addition to assisting in esthetic analysis and simulation, the technology can contribute to making the planning process more agile and efficient.

3.2 Limitations of the available evidence

Despite the promising results, the analyzed studies present methodological limitations that restrict the possibility of establishing definitive conclusions about the clinical applicability of artificial intelligence in esthetic planning. One of the main limitations is related to the design of the studies and to patient follow-up. The workflow proposed by Song *et al.* (2026), although presenting high technical sophistication, had its applicability demonstrated in only one participant and in a predominantly descriptive manner. Furthermore, none of the evaluated studies followed the patients after the treatment was performed. Thus, it remains uncertain to what extent the planned result corresponds to the result obtained clinically, as well as whether the results achieved are stable over time, a limitation also highlighted by Saini *et al.* (2025).

Another important limitation refers to the outcomes used to evaluate the performance of technology. Most studies prioritized subjective measures, such as patient satisfaction,

esthetic preference, and evaluation by specialists. Although these parameters are relevant for the evaluation of esthetic perception, they do not allow one to determine, in isolation, whether the planning performed with the aid of AI presents greater accuracy or predictability in relation to the clinical result obtained. Thus, the available findings mainly demonstrate the capacity of the technology to produce esthetically accepted plans, but do not yet prove its capacity to reproduce these results accurately in clinical practice. This interpretation is particularly relevant considering the findings of Saini *et al.* (2025), whose review identified a pooled satisfaction of 58%, with wide variability among the studies, a moderate risk of methodological limitations, and possible indications of publication bias.

The transparency of the systems constitutes another relevant issue. In the study by Binvignat *et al.* (2025), the deep learning-based method presented greater accuracy in the reconstruction of the anatomy of the central incisors, but presented lower interpretability, making it impossible to clearly determine which characteristics used by the algorithm contributed to the definition of the final shape. This characteristic may represent a limitation for clinical practice, considering that the dentist remains responsible for the evaluation, indication, and decision-making during restorative planning. Furthermore, part of the studies was developed by the very researchers responsible for the tools evaluated, which should be considered in the interpretation of the results. Song *et al.* (2026), for example, reported the existence of a pending patent application related to the developed method, highlighting the need to consider possible conflicts of interest and the independence of the evaluations.

Finally, the incorporation of artificial intelligence into esthetic planning also involves ethical issues related to professional responsibility, patient autonomy, and equity in access to technology. Rokhshad *et al.* (2024) gathered experts from different countries to establish guiding principles for the use of AI in smile design. In the first round of evaluation, there was consensus on seven of the eleven proposed principles, while those related to equity, responsibility, solidarity, and respect for autonomy did not reach sufficient agreement and needed to be reformulated. These results show that, in addition to technical aspects, the use of AI in clinical practice still demands discussions on the responsibility for treatment decisions and outcomes, as well as on the role of the patient in the definition of the proposed planning.

3.3 Implications of the findings for direct composite resin restorations

The studies included in this review were conducted predominantly in the context of indirect rehabilitations or of esthetic planning in general. None of the evaluated works specifically investigated the application of artificial intelligence in the planning of direct composite resin restorations. Thus, although some of the findings may be extrapolated to the direct technique, this transposition should be carried out with caution, considering the particularities involved in each restorative modality.

Among the contributions identified, some present potential for application regardless of the material or restorative technique employed. Facial symmetry analysis, the definition of dental proportions, and the prior simulation of the result are stages related to diagnosis and esthetic planning and may assist both the planning of indirect restorations and direct composite resin procedures. In this sense, the use of AI can contribute to a more objective definition of the expected result before the beginning of the clinical intervention.

However, there are important differences between the planning of indirect rehabilitations and that of direct restoration. In indirect techniques, digital planning can be converted into a file used for the fabrication of the restoration through automated processes, such as milling or printing, favoring the transfer of the design to the laboratory stage (Tallarico, 2020). In direct techniques, on the other hand, the execution of the planning takes place directly in the oral cavity and depends on the skill of the professional to reproduce the previously defined characteristics. Thus, although AI may assist in determining the shape, proportion, and positioning of the teeth (Almohareb *et al.*, 2026; Kaushik *et al.*, 2025; Song *et al.*, 2026), its use does not replace the clinical and operator-dependent aspects inherent to direct restorative procedures (Demarco *et al.*, 2015).

Thus, the available findings suggest that the main contribution of artificial intelligence to direct composite resin restorations would be related to the planning stage, with the potential to reduce subjectivity in the definition of tooth shape and proportions and to facilitate communication of the expected result (Cattoni *et al.*, 2019; Garcia *et al.*, 2018; Simon; Magne, 2008). However, the limited evidence specifically addressing its application in direct restorative techniques prevents the assertion that these benefits translate into greater accuracy,

predictability, or clinical longevity. It is therefore necessary to conduct clinical studies that investigate the integration of artificial intelligence into the planning and execution of direct composite resin restorations, including the comparison between planned and obtained results.

3.4 Gaps in the literature and perspectives for future research

The number of studies identified highlights the limited scientific production available on the application of artificial intelligence to esthetic planning in dentistry. Of the 132 articles initially identified in the databases consulted, only seven met the eligibility criteria and specifically addressed the use of artificial intelligence in the esthetic planning of anterior teeth. Most of the excluded studies investigated applications of the technology in other areas of dentistry, especially those related to imaging diagnosis and the detection of carious lesions. Furthermore, all the included studies were published between 2024 and 2026, indicating that the application of artificial intelligence to esthetic planning constitutes a recent and still developing area of investigation. This scenario may contribute to the limited availability of comparative studies, as well as to the absence of longitudinal clinical evaluations capable of verifying the correspondence between the planned results and those obtained.

The gap becomes even more evident when the application of artificial intelligence to direct composite resin restorations is considered. Among the included studies, no work was identified that specifically investigated the use of this technology in the planning of direct restorations in anterior teeth. The available literature focuses mainly on indirect rehabilitations and on esthetic planning in a broad sense, in which the digital workflow can be integrated with the subsequent fabrication stages through CAD/CAM systems. In the direct technique, however, the transfer of the planning to the oral cavity remains predominantly dependent on clinical execution by the professional, which reveals an important gap regarding the applicability and effectiveness of artificial intelligence in this context.

In view of this, the results of this review point to the need to expand the investigation into the use of artificial intelligence in the planning of direct composite resin restorations. Prospective clinical studies, with larger samples, comparative groups, and longitudinal follow-up, are needed to evaluate not only the esthetic acceptance of AI-generated plans, but also the

accuracy of the transfer to the clinical result, the predictability of the treatment, and the stability of the restorations over time. The production of evidence with this design may contribute to determining more consistently the real role of artificial intelligence in direct restorative practice.

CONCLUSION

The present review made it possible to identify the main contributions and limitations of artificial intelligence in the digital planning of esthetic restorations in anterior teeth. The available studies indicate that the technology has the potential to assist in facial symmetry analysis, in the definition of dental proportions, and in the simulation of the esthetic result, in addition to contributing to the reduction of the time devoted to planning and enabling new forms of smile visualization, including its representation in motion.

However, the available evidence is still recent, scarce, and presents important methodological limitations. Subjective evaluations related to patient satisfaction and esthetic preference predominate, while the accuracy of the planning, its correspondence with the clinical result, and the stability of the results over time remain little explored. Furthermore, none of the included studies specifically investigated the application of artificial intelligence in the planning of direct composite resin restorations.

Thus, artificial intelligence demonstrates potential as an auxiliary tool for esthetic planning but should not be considered a substitute for the clinical judgment and the work of the dentist. Its main contribution is related to the stage of treatment conception and visualization, while the execution of direct restorations remains dependent on the performance and clinical skills of the professional. The absence of specific evidence for the direct technique therefore constitutes an important gap in literature, reinforcing the need for clinical studies that evaluate the accuracy of the transfer of the digital planning to the restorative result obtained.

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