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Computer vision in dentistry: from pixels to clinical decision-making

Visión por computador en odontología: de los píxeles a la toma de decisiones clínicas

Visão computacional na odontologia: dos pixels à tomada de decisão clínica

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Dear Editor,

Currently, computer vision in Dentistry has become a key component of the digital workflow by transforming clinical and radiological images into structured data that support diagnosis, treatment planning, and follow-up. Its applications include intraoral and panoramic radiographs, cone-beam computed tomography (CBCT), clinical photography, facial stereo photogrammetry, and intraoral scanning (1–5).

The process involves standardized image acquisition, segmentation, classification, and the generation of clinically interpretable reports. Deep learning has shown particular relevance by enabling the automatic identification of patterns from pixels or voxels; however, its performance depends on image quality, standardized acquisition protocols, and the availability of expert annotations. When integrated into clinical practice, computer vision does not replace clinical judgment but rather acts as a second reader, prioritizing findings and reducing diagnostic variability, particularly in high-demand clinical settings (5–9).

In dental radiology, computer vision has shown considerable potential to support screening and diagnosis across different imaging modalities. In panoramic radiographs, systems capable of identifying mandibular cortical thinning associated with reduced bone mineral density have been evaluated, facilitating timely referral for densitometry in susceptible patients (8,9). In periapical and bitewing radiographs, convolutional neural networks (CNNs) enable the detection of carious lesions and the estimation of their radiographic extent, as well as the identification of periapical lesions. Nevertheless, systematic reviews report high but heterogeneous performance, with potential methodological bias. Therefore, reporting sensitivity, specificity, and external validation is essential, given that the clinical impact of errors varies according to lesion type and stage, to ensure that these technologies provide reliable and safe support for clinical decision (7–9).

Similarly, advances in CBCT and intraoral scanning illustrate how computer vision can enhance digital workflows through automated segmentation, three-dimensional reconstruction, and integration with CAD/CAM techno-

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logies. These developments facilitate treatment planning in endodontics, surgery, orthodontics, and prosthodontics by improving workflow efficiency and interoperability between digital datasets. Nevertheless, the clinical value of these technologies extends beyond technical performance. Their successful integration into routine dental practice requires scientific validation, transparency and responsible implementation to ensure that technological innovation translates into meaningful improvements in patient care (8,9).

In soft tissues, facial segmentation and automated cephalometric landmark detection in three-dimensional images provide reproducible measurements for orthodontics, orthognathic surgery, and esthetic evaluation. The multimodal integration of dental and facial data enables the construction of a comprehensive virtual patient by integrating clinical, radiological, and morphological information into a unified digital representation. This virtual patient may constitute a key component of a future digital twin approach, supporting personalized therapeutic planning and outcome prediction.

However, responsible implementation requires multicenter external validation, analysis according to demographic variables, transparent data reporting, and prospective evaluation of clinical impact. Additionally, data governance, privacy, and cybersecurity considerations are essential to ensure ethical and sustainable adoption (9,10).

In conclusion, the integration of computer vision into digital dental workflows represents a substantial advancement in the way clinical information is acquired, processed, and interpreted. Advanced image processing and interoperability with three-dimensional models enable the development of a comprehensive virtual patient, supporting more accurate diagnosis and clinical decision-making.

Through this technological convergence, it is now possible to develop more precise and individualized treatment plans, expanding planning capabilities and enhancing clinical predictability. The evolution of these tools not only transforms clinical practice but also reshapes how knowledge is understood, taught, and applied in dentistry. In this context, computer vision emerges as a strategic component that calls for critical, evidence-based adoption to strengthen clinical decision-making and provide safer, more personalized therapeutic alternatives.

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