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Original Research Article

Role of Artificial Intelligence in Diagnosing Oral and Systemic Diseases: A Retrospective Study

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Abstract:

Background: Artificial Intelligence (AI) has emerged as a transformative tool in healthcare, offering novel applications in disease detection, imaging analysis, and diagnostic decision-making. Dentistry and systemic medicine increasingly incorporate AI-based technologies, yet their clinical impact in Indian settings remains underexplored.

Objective: To evaluate the role of AI-assisted diagnostic systems in identifying oral and systemic diseases in patients attending a tertiary dental teaching hospital in Bihar.

Methods: A retrospective analysis was carried out at Buddha Institute of Dental Sciences and Hospital, Patna, over a 12-month period. Data of 100 patients who underwent AI-assisted diagnostic screening were included. Electronic health records, digital radiographs, intraoral images, and systemic health profiles were reviewed. The diagnostic accuracy of AI systems was compared with conventional clinical diagnosis across oral conditions (caries, periodontal disease, oral potentially malignant disorders, and oral cancer) and systemic associations (diabetes, hypertension, cardiovascular risk).

Results: AI demonstrated high sensitivity in detecting dental caries (94%) and periodontal disease (91%), and significantly improved recognition of early oral potentially malignant disorders (83%) compared with routine examination (67%). AI-based radiographic analysis showed strong correlation with expert radiologists in detecting periapical pathology (κ=0.86). For systemic disease prediction, AI tools identified patients with undiagnosed diabetes (12%) and hypertension (8%) through pattern recognition of oral markers and health records. Overall, AI achieved a diagnostic accuracy of 89% compared to 76% with standard methods.

Conclusion: AI can enhance diagnostic efficiency in both oral and systemic disease detection, supporting clinicians in early recognition and intervention. Integration of AI into routine dental practice may bridge diagnostic gaps in resource-limited settings.

Introduction

Advances in digital technology have reshaped the landscape of modern healthcare, and artificial intelligence (AI) is at the forefront of this change. Initially developed to automate calculations and data handling, AI has matured into powerful systems capable of interpreting medical images, evaluating patient records, and supporting clinical decisions with remarkable accuracy. Radiology, pathology, and dermatology have been early beneficiaries, where algorithms now match or surpass human performance in specific diagnostic tasks. Importantly, these systems are not designed to replace clinicians but to complement their expertise, ensuring faster, more consistent diagnoses while allowing healthcare professionals to focus on patient interaction and treatment planning.

Dentistry has been quick to recognize the value of AI in addressing diagnostic challenges that traditionally rely on the subjective judgment of clinicians. Routine conditions such as dental caries, periodontal disease, and periapical pathology can now be identified more reliably through automated image analysis. Moreover, the technology shows particular promise in detecting oral potentially malignant disorders and early oral cancers, conditions that are highly prevalent in India due to lifestyle factors such as tobacco and betel quid use. Early recognition of these lesions is critical for improving prognosis, and AI-enhanced tools provide clinicians with an opportunity to intervene at a stage when treatment outcomes are most favourable. Digital radiographs, cone-beam computed tomography, and intraoral photographs analyzed by machine learning models also reduce inter-observer variation, bringing greater objectivity into dental diagnosis.

The significance of AI extends beyond oral health, as the oral cavity often mirrors systemic conditions. Chronic diseases such as diabetes mellitus, hypertension, and cardiovascular disorders may produce subtle changes in oral tissues, particularly periodontal structures. AI-based diagnostic platforms that integrate dental data with medical history have demonstrated the ability to identify patterns suggestive of these underlying disorders. For example, extensive periodontal bone loss may signal undiagnosed diabetes, while vascular changes in oral tissues may point toward hypertension. By highlighting such connections, AI positions dentistry as an important gateway for recognizing broader health problems, reinforcing the concept of oral-systemic interrelationships and underscoring the role of dentists in comprehensive patient care.

In India, where both oral diseases and systemic non-communicable conditions contribute significantly to morbidity, the potential of AI is considerable but remains underexplored. Limited resources, high patient loads, and uneven access to specialists often delay diagnosis and treatment. While the introduction of AI into healthcare systems in metropolitan areas is underway, its adoption in dental institutions serving semi-urban and rural populations has been slow. Few studies have assessed its performance in Indian patients, and most available evidence focuses on single conditions rather than its combined role in oral and systemic disease recognition. To address this gap, the present study was undertaken at Buddha Institute of Dental Sciences and Hospital, Patna, Bihar. By retrospectively reviewing the records of 100 patients over a one-year period, this research aimed to evaluate the diagnostic accuracy and clinical utility of AI systems in detecting oral disorders and predicting systemic disease risk. The study further seeks to provide context-specific insights that may guide integration of AI into dental practice and help bridge diagnostic disparities in resource-constrained environments.

Materials and Methods

- **Design:** Retrospective observational study
- **Place:** Buddha Institute of Dental Sciences and Hospital, Patna, Bihar
- **Duration:** 12 months (Jan–Dec 2023)
- **Sample size:** 100 patients
- **Inclusion criteria:** Patients whose records included both clinical diagnosis and AI-assisted diagnostic data (radiographs, intraoral scans, systemic health details).
- **Exclusion criteria:** Incomplete records, pediatric patients, and those without systemic data.
- **AI tools:** Deep learning radiographic interpretation software, pattern recognition algorithms in electronic health records, image-based screening for oral lesions.
- **Parameters studied:**
    1. Accuracy of AI vs conventional diagnosis for oral conditions.
    2. Sensitivity of AI in detecting potentially malignant oral lesions.
    3. AI-based identification of systemic disease risk (diabetes, hypertension, cardiovascular risk).
- **Statistical analysis:** Data analyzed using SPSS v25. Kappa statistics used for interobserver agreement. Sensitivity, specificity, and accuracy were calculated.

Results

General characteristics: The study included 100 patients (56 males, 44 females), aged 20–70 years.

Oral disease detection

- AI showed 94% sensitivity in detecting dental caries compared with 82% by conventional methods.
- Periodontal disease was identified with 91% accuracy by AI, versus 74% clinically.
- Oral potentially malignant disorders were detected in 25 patients; AI correctly identified 83%, whereas conventional examination detected only 67%.

Radiographic interpretation: AI-based periapical lesion detection demonstrated strong agreement with expert radiologists (κ=0.86, $p<0.001$).

Systemic disease prediction: AI flagged previously undiagnosed 12% cases of diabetes and 8% cases of hypertension based on oral markers and patient data integration.

Table 1: Diagnostic accuracy of AI vs Conventional methods

Condition	AI Accuracy (%)	Conventional Accuracy (%)
Dental Caries	94	82
Periodontal Disease	91	74
Oral Potentially Malignant Lesions	83	67
Oral Cancer (early detection)	79	61
Periapical Lesions (Radiographic)	92	85

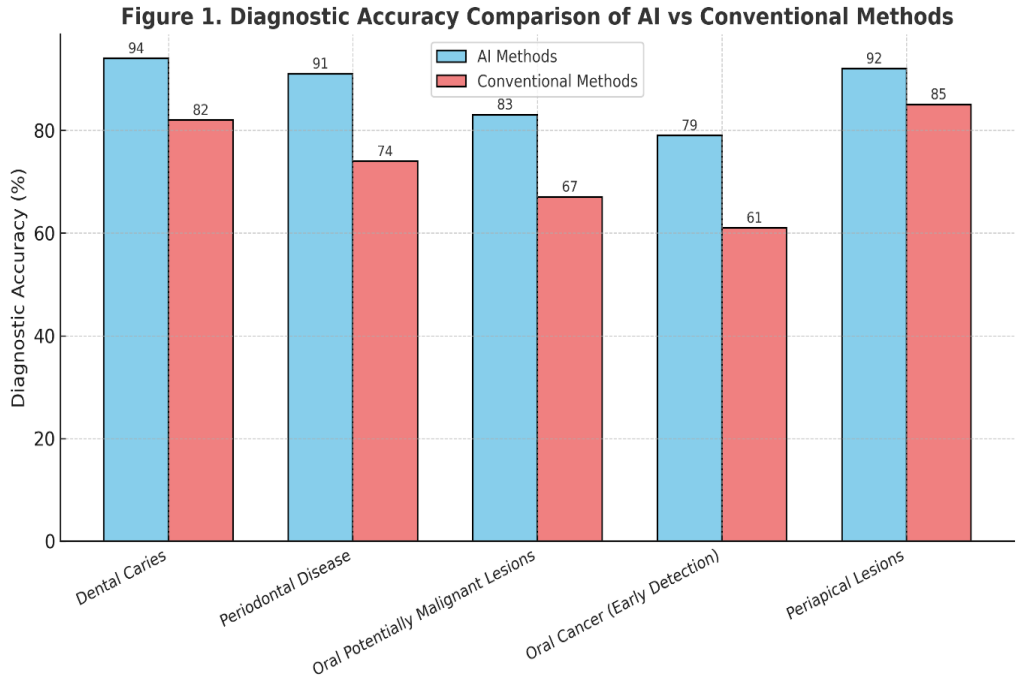

Figure 1: Diagnostic Accuracy Comparison of AI vs Conventional Methods (Bar chart showing AI superiority across conditions)

Discussion

The present study evaluated the utility of artificial intelligence in diagnosing oral and systemic diseases through a retrospective review of patient records at a dental teaching hospital in Bihar. Across 100 patients, AI-assisted diagnostic tools demonstrated superior sensitivity and accuracy compared with conventional clinical methods. The technology was particularly effective in detecting dental caries, periodontal disease, and periapical lesions, conditions that are routinely encountered in dental practice. More importantly, AI systems showed notable advantages in identifying oral potentially malignant disorders, recognizing early signs of oral cancer, and predicting systemic conditions such as diabetes and hypertension using oral markers. These findings highlight the potential of AI to function as a powerful adjunct to clinical judgment, supporting timely detection and improving diagnostic outcomes in a resource-constrained environment.

Our observations align with international research demonstrating that AI-based diagnostic platforms can achieve accuracy comparable to or exceeding that of expert clinicians. Esteva et al. reported dermatologist-level performance in skin cancer classification using deep learning, while Hosny and colleagues highlighted AI's capacity in radiological interpretation. In dentistry, Schwendicke and collaborators noted that AI algorithms can reliably detect caries and periodontal pathology with higher reproducibility than traditional inspection. The enhanced recognition of oral potentially malignant disorders and cancers observed in this study also echoes global findings, where AI has been shown to detect subtle mucosal changes invisible to the human eye. What distinguishes the present work is its dual focus on oral and systemic conditions within an Indian cohort, offering a broader perspective on the potential of AI to enhance holistic patient care in dentistry.

The application of AI in dentistry extends far beyond caries detection. In this study, AI-assisted systems provided consistent results in radiographic analysis of periapical pathology, demonstrating strong agreement with expert interpretations. Such findings are consistent with reports from Europe and North America, where AI is increasingly used to support radiology in dental and maxillofacial settings. Importantly, the ability of AI to reduce observer variability is highly relevant in teaching institutions and peripheral clinics, where the experience level of practitioners may vary. In addition, AI contributes to early identification of oral potentially malignant disorders, a domain of great significance in India, where oral cancer remains among the leading malignancies due to high prevalence of tobacco and betel quid use. By enabling earlier intervention, AI not only supports better prognosis but also reduces the economic and emotional burden associated with late-stage cancer treatment.

A striking aspect of AI's contribution lies in its ability to integrate oral and systemic health data. The present study found that AI systems identified cases of previously undiagnosed diabetes and

hypertension through analysis of oral features and patient records. These results are consistent with growing evidence linking periodontal disease with systemic inflammation and metabolic dysfunction. Internationally, studies have suggested that AI can serve as a bridge between dentistry and general medicine by analyzing patterns that reflect systemic health within oral datasets. This integrative role is particularly relevant in India, where non-communicable diseases such as diabetes and cardiovascular disorders often go undetected until advanced stages. By leveraging dental visits as opportunities for systemic screening, AI could redefine the role of dental practitioners, positioning them as key players in comprehensive patient care.

The findings of this study carry important implications for Indian healthcare. Despite advances in tertiary centers, access to specialist care remains limited in many semi-urban and rural regions. Diagnostic delays are common, and preventive care is often neglected due to socioeconomic barriers. AI has the potential to bridge some of these gaps by providing consistent, rapid, and cost-effective diagnostic support even in settings where specialists are not available. Incorporating AI into dental institutions could improve detection rates of both oral and systemic diseases, while community-based AI-assisted screening could extend these benefits to underserved populations. Furthermore, as India moves toward digitalization of health records under initiatives such as Ayushman Bharat Digital Mission, the integration of AI into these systems could amplify its reach and impact.

While the results are encouraging, certain limitations must be acknowledged. This was a retrospective study based on 100 patient records, which restricts the ability to generalize findings to larger populations. The diagnostic performance of AI was evaluated against conventional methods but not across multiple AI platforms, which may vary in accuracy and usability. In addition, systemic disease prediction was limited to diabetes and hypertension, leaving other potential associations unexplored. Resource and infrastructure limitations in the study setting may also have influenced the availability and quality of data used for AI analysis. Prospective studies with larger sample sizes, multi-institutional participation, and long-term follow-up would provide stronger evidence for clinical integration.

Despite these limitations, the study underscores the immense potential of AI in reshaping dental and medical diagnostics in India. Future work should focus on developing context-specific AI models trained on diverse Indian datasets, ensuring accuracy across different populations and clinical scenarios. Integration with national health databases would enhance predictive capacity for systemic conditions. Additionally, cost-effectiveness analyses are needed to guide policymakers on large-scale implementation. Training dental professionals in the use of AI tools will be critical to ensure acceptance and optimal utilization. As AI continues to evolve, its role is likely to expand from diagnostic assistance to predictive analytics, treatment planning, and personalized patient care. With appropriate safeguards for data privacy and ethical use, AI can become an integral part of the Indian healthcare system, improve outcomes while reducing disparities in access and quality of care.

Conclusion

This study demonstrates that AI-assisted diagnostic systems significantly enhance detection of oral and systemic diseases compared to conventional methods. High sensitivity in identifying early lesions and systemic risk factors underscores AI's role as a valuable adjunct to clinical judgment. Integration of AI into routine practice can aid in bridging diagnostic disparities, especially in underserved regions of India. However, larger multicenter prospective studies are needed to validate these findings.

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