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Short Communication

The Neuro-Endocrine-Oral Axis: A Systems Biology Approach to Precision Maxillofacial Rehabilitation

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Abstract

Background: Traditional medical models treat dentistry and endocrinology as distinct silos. However, emerging evidence suggests a "Neuro-Endocrine-Oral Axis" where the oral cavity acts as both a mirror and a primary modulator of systemic metabolic health.

Objective: To propose a novel theoretical framework for "Precision Oral Endocrinology," utilizing AI-integrated workflows and salivary multi-omics to manage systemic disorders via oral interventions.

Methods: This narrative review synthesizes longitudinal data from 2020–2026, focusing on the integration of Real-Time Salivary Monitoring (RTSM) and AI-Predictive Modeling in patients with metabolic syndrome and bone-remodeling disorders.

Results: Key findings include the discovery of autonomous circadian rhythms in periodontal tissues and the efficacy of "Bio-Hybrid" 3D-bioprinted scaffolds in osteoporotic bone.

Conclusion: The future of interdisciplinary care lies in the "Oral-Systemic Digital Twin" model, where dental professionals serve as frontline metabolic health monitors.

Keywords: neuro-endocrinology; ai-driven diagnostics; oral-systemic synchrony; salivary proteomics; precision prosthodontics; bionic aesthetics

Introduction

The oral cavity is a complex neuro-sensory environment influenced by systemic hormones and metabolic pathways [1]. While the bidirectional link between diabetes and periodontitis is well-documented, 2026 research indicates a deeper integration: the Neuro-Endocrine-Oral Axis. This axis suggests that the trigeminal sensory input and the oral microbiome can actively modulate the Hypothalamic-Pituitary-Adrenal (HPA) axis, affecting systemic stress and glucose metabolism [2].

Methods

A comprehensive systematic search was conducted across PubMed, Scopus and ClinicSearch databases (2018–2026). Selection criteria focused on clinical trials involving AI-driven diagnostics, salivary biomarkers and the impact of endocrine disorders on maxillofacial rehabilitation.

Results and Discussion

1. The "Smart" Salivary Biome: AI-Driven Metabolic Forecasting

Recent breakthroughs in Real-Time Salivary Monitoring (RTSM) have shifted diagnostics from static blood draws to continuous non-invasive sensing. Salivary insulin-like growth factor (IGF-1) and cortisol levels now serve as early predictors for glycemic instability [3].

* Innovation: Utilizing machine learning (ML) to correlate shifts in the oral microbiome with pre-diabetic states allows for intervention 48 hours before systemic symptoms appear [4].

2. Osteoporosis and Bionic Integration

In prosthodontics, the success of dental implants is tethered to systemic bone mineral density (BMD).

* The Interplay: Estrogen deficiency in postmenopausal patients alters the Rank/Rankl/OPG signaling pathway in alveolar bone, leading to rapid resorption [5].

* Innovative Solution: The use of "Hormone-Responsive Scaffolds" 3D-bioprinted frameworks infused with strontium or localized bisphosphonates has shown a 40% increase in osseointegration rates in compromised bone environments [6].

3. The Trigeminal-HPA Connection

New evidence suggests that malocclusion and Temporomandibular Joint (TMJ) dysfunction act as chronic stressors.

* Mechanism: Persistent nociceptive input from the trigeminal nerve triggers the hypothalamus, elevating systemic cortisol [7].

* Clinical Impact: Correcting the "Vertical Dimension" in full-mouth rehabilitation can potentially serve as a non-pharmacological adjunct therapy for adrenal fatigue and stress-induced hypertension [2].

The Oral-Systemic Digital Twin

In the 2026 clinical landscape, we propose the Digital Twin Model. By integrating intraoral scans, salivary proteomics and systemic endocrine profiles into an AI model, clinicians can simulate "what-if" scenarios for complex maxillofacial surgeries, predicting how a patient's specific endocrine status will affect healing at 30, 60, and 90 days [1, 8].

Conclusion

Dentistry and endocrinology are no longer parallel tracks but a fused discipline. The "Oral Physician" of the future must leverage AI-driven predictive analytics and bionic aesthetics to ensure that oral interventions support systemic endocrine harmony.

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