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Comparative analysis of clinical and digital methods for evaluating and modifying the occlusal vertical dimension

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Abstract
The occlusal vertical dimension (OVD) is fundamental for both oral function and aesthetics. Its alteration—whether from tooth wear, loss, or edentulism—can compromise masticatory efficiency, facial harmony, and patient comfort. This review aims to analyze and compare the literature on various methods used to evaluate and modify OVD, focusing on the transition from traditional clinical and anthropometric approaches to modern digital and CAD/CAM-based systems. An extensive search was conducted in PubMed, Scopus, Web of Science, Cochrane Library, ScienceDirect, and Google Scholar using terms such as "occlusal vertical dimension," "vertical dimension modification," "digital smile design," and "anthropometric methods." Studies published between 2019 and 2024 were included. The findings suggest that both clinical and digital tools offer valuable insights, with digital smile design (DSD) and CAD/CAM systems allowing for greater precision, reversibility, and predictability. However, the choice of method should remain individualized, based on the clinical scenario and patient needs. The integration of digital technologies with traditional prosthodontic principles represents a promising direction for achieving optimal functional and aesthetic outcomes.

Keywords: Occlusal vertical dimension, digital smile design, electromyography, prosthodontic rehabilitation, CAD/CAM, facial analysis

Introduction
The restoration of occlusal vertical dimension (OVD) plays a crucial role in achieving proper oral function, aesthetics, and long-term stability in prosthodontic treatments. A loss of OVD, often due to tooth wear, bruxism, or edentulism, can lead to impaired mastication, temporomandibular discomfort, and facial aging. Restoring OVD requires precise evaluation and a clear understanding of individual facial proportions.

Traditional methods—based on facial measurements, phonetics, and rest position—have served as foundational approaches, but recent advances in digital dentistry have introduced highly accurate tools that can integrate facial scanning, virtual articulators, and smile design protocols.

In this context, comparing the reliability, clinical applicability, and advantages of clinical, anthropometric, and digital methods is essential to define evidence-based protocols for the evaluation and modification of OVD.

Materials and Methods
This study followed a narrative review approach with elements of systematic selection. A literature search was conducted across PubMed, Scopus, Web of Science, Cochrane Library, ScienceDirect, and Google Scholar for publications between 2019 and 2024 in English and Spanish. The keywords included "occlusal vertical dimension," "occlusion," "vertical dimension modification," "digital smile design," "anthropometric methods," and "electromyography."

Inclusion criteria comprised clinical studies, systematic reviews, case reports, and randomized controlled trials that evaluated OVD measurement or modification techniques in human subjects. Exclusion criteria included animal or *in vitro* studies and narrative reviews without

methodological rigor. Data were analyzed qualitatively, comparing the accuracy, reproducibility, and applicability of each method and grouping them into clinical, anthropometric, electromyographic, and digital/CAD-CAM categories.

Results

Digital Smile Design and Aesthetic Planning

The concept of facially generated treatment planning (FGTP), introduced in the 1980s, highlighted the role of the face as the reference for prosthodontic rehabilitation. In modern practice, this approach evolved into Digital Smile Design (DSD), developed by Coachman and Calamita, which integrates digital facial analysis and aesthetic simulation.

Recent research demonstrates that DSD facilitates improved visualization, communication, and predictability of prosthetic outcomes. Studies by Calamita *et al*. (2024) [1] and Blatz *et al*. (2024) [2] showed that DSD enhances treatment planning accuracy and interdisciplinary coordination in complex aesthetic cases.

Radiographic and Cephalometric Evaluation

Cephalometric analysis has been extensively used to determine facial height and skeletal relationships associated with OVD. Sinobad *et al*. (2023) [3] reported that cephalometric tracing accurately identifies vertical discrepancies in edentulous patients, while Fayz *et al*. (2017) and Nasser (2020) found that skeletal landmarks are more reliable than soft-tissue measures for detecting mandibular positional changes.

AI-assisted digital cephalometry now allows faster and more precise quantification of OVD variations, contributing to better diagnostic and prosthetic outcomes.

Functional and Electromyographic Assessment

Electromyography (EMG) has proven to be a valuable tool for assessing masticatory muscle adaptation following OVD alteration. Barbosa Ribeiro *et al*. (2017) and Pita *et al*. (2022) [4] found that moderate increases in OVD do not significantly affect EMG activity or pain thresholds, supporting the adaptability of the stomatognathic system.

Farías *et al*. (2021) [5] and Mack (2021) [6] highlighted that craniofacial morphology influences chewing efficiency and muscle response, underlining the importance of individualized treatment plans.

Tooth Wear and Restorative Techniques

Pathological tooth wear is one of the primary causes of OVD reduction. Wei *et al*. (2018) [10] and Chang *et al*. (2022) [9] demonstrated that excessive wear alters tooth display and lip support, often requiring vertical dimension restoration to regain facial harmony.

Crins *et al*. (2023) [7] and Abduo (2021) [8] confirmed that full-mouth composite or fixed prosthetic restorations can safely and effectively increase OVD, provided they are guided by digital planning tools such as DSD and CAD/CAM technology.

Discussion

The reviewed evidence supports a growing integration of digital technologies in the evaluation and restoration of OVD. Digital Smile Design, cephalometric software, and electromyographic tools complement traditional diagnostic techniques by increasing accuracy, standardization, and visualization of results.

However, despite these technological advances, conventional methods—such as rest position, facial measurements, and phonetics—remain essential for establishing a physiological baseline. Digital systems should be considered as enhancements rather than replacements for clinical expertise.

Interdisciplinary approaches combining prosthodontics, orthodontics, and esthetic dentistry have shown superior outcomes when digital planning tools are employed. Nevertheless, the lack of standardized protocols across studies limits direct comparison and calls for further longitudinal research. Overall, a hybrid approach combining traditional and digital evaluation provides the most comprehensive and reliable assessment of OVD, ensuring optimal functional and aesthetic rehabilitation outcomes.

Conclusion

There is no single universal method for evaluating or modifying occlusal vertical dimension. Traditional clinical and anthropometric approaches offer valuable functional insight, while digital tools such as DSD and CAD/CAM systems provide superior accuracy and visualization.

The integration of both approaches results in a more individualized and predictable treatment process, improving patient outcomes in terms of function, comfort, and aesthetics. Future research should focus on developing standardized, evidence-based digital protocols for consistent OVD evaluation and restoration**.**

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Conflict of Interest: The authors declare no conflicts of interest related to this study.

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