

Review

How to Be Predictable in the Management of Vertical Dimension of Occlusion—A Narrative Review and Case Report

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Abstract

This narrative review addresses the complexities of managing the vertical dimension of occlusion (VDO) in restorative dentistry, focusing on predictability in prosthetic reconstructions. Altering VDO impacts biological, biomechanical, esthetic, and functional aspects, making it a controversial topic. While VDO naturally evolves throughout life, interventions require careful consideration due to potential complications. Various techniques guide VDO determination, including facial proportions, physiological methods, phonetics, and cephalometric analysis. Clinicians must understand these principles and adapt them to individual patient needs. **Materials and Methods:** A narrative literature review was conducted using PubMed, Scopus, Google Scholar, and the Cochrane Library, searching keywords like “vertical dimension of occlusion”, “dental”, “diagnosis”, “management” and “complications”. In addition to the literature review, two case reports with extensive prosthodontic restorations were included to illustrate the diagnostic challenges and treatment considerations in a clinical setting. **Results:** Increasing VDO aids restorative treatments, re-establishing morphology, and facilitating additive procedures. Minimally invasive approaches, provisional restorations, and fixed restorations with functional contours are favored. Individualized, patient-centered care is critical, recognizing unique anatomical and functional needs. This approach optimizes stomatognathic system rehabilitation while preventing adverse effects on body posture and airway dimensions. **Conclusions:** To ensure predictable results and minimize risks, changes in VDO should be kept to a minimum to achieve dentofacial aesthetic harmony and secure adequate space for the planned restorations. The two case reports presented, with different clinical approaches, underline the importance of understanding the potential risks and benefits of VDO alteration which is crucial for achieving predictable and successful outcomes in complex restorative cases.

Keywords: vertical dimension of occlusion; prosthodontic restoration; minimal invasive dentistry; cephalometry



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1. Introduction

1.1. Definition

Dental clinicians face a challenge in their everyday practice when managing complex prosthetic restorations in cases involving an altered vertical dimension of occlusion (VDO) [1,2]. The VDO, or the distance between the maxilla and the mandible, is one of the most controversial issues in restorative dentistry. Changes in the VDO can have biological, biomechanical, aesthetic, and functional implications, as the initial references for maximum intercuspation and anterior tooth relationships must be reconstructed and adjusted to a new spatial dimension [3].

1.2. Etiology and Clinical Signs

The VDO evolves throughout life. It progresses from a dentate phase with complete arches, to a phase with loss of posterior support, and finally to total edentulism, which is characterized by a clinically evident reduction in the VDO. These changes can be externally observed by the deepening of perioral folds, thinner lips, and an aged appearance [4].

Although increasing the VDO is a safe procedure when appropriately indicated and carried out, complications can still arise. Factors such as tooth wear, tooth loss, supra-eruption, or alterations to existing prostheses can determine alterations of the VDO [5]. Numerous studies indicate a prevalent trend toward increased tooth wear with advancing age. The prevalence of tooth wear varies considerably worldwide, with estimates ranging from 29% to 60% of the global population [6]. Adjusting the VDO is a complex process involving an integrative approach that requires clinical assessments of facial and dental aesthetics, phonetics and occlusion, and anatomical landmarks. Additional space for restorative materials and dentofacial esthetic harmonization can be achieved by carefully increasing the VDO [7]. However, some authors consider that altering the VDO could lead to hyperactivity of the masticatory muscles, higher occlusal forces, and temporomandibular disorders (TMDs), while others claim it is a safe procedure [8–11].

From a symptomatic point of view, dental wear often leads us to suspect a possible reduction in VDO, but each case must be analyzed carefully. Therefore, clinicians must be aware that dental wear in the anterior region of the arch does not necessarily indicate a loss of VDO. In most Class II cases, anterior tooth wear is due to malocclusion, and the changes are even more severe when associated with parafunctions. Angle Class III patients usually show wear on the anterior teeth [12]. The incisal edges wear gradually, and the mandibular position tends to become posteriorly displaced. Generally, when anterior tooth wear is accompanied by the same dental structure loss in the posterior region, this indicates a reduction in VDO. Clinically, to confirm this loss, the condition and position of the posterior teeth should be observed, as they are responsible for maintaining the VDO. In general, if they are well positioned, with minimal signs of wear, it is unlikely that VDO has decreased. Conversely, in cases with loss of support in the posterior area, a reduction in VDO is common [13]. However, a thorough evaluation of the case is essential, since compensatory eruptive phenomena may occur.

1.3. Diagnosis

Due to the irreversibility of some procedures, the complexity of the work involved, and the financial implications of such extensive dental treatment, clinicians must have compelling reasons to alter VDO from a restorative perspective [9,10]. Accepted techniques for determining VDO include facial or morphological proportions, physiological methods based on physiologic rest position, phonetics, and cephalometric analysis [14–17]. For over a century researchers and clinicians have been concerned with the analysis of VDO. Turner and Fox recommended that facial proportions be determined based on the external

appearance of the face, referring to the shape of the nasolabial folds, the harmony between the lower third and the other thirds of the face, as well as consistency with the patient's age [18]. In 1930, Willis proposed that the distance from the outer corner of the eye to the corner of the mouth was equal to the distance from the base of the nose to the chin and developed the Willis occlusion meter for such measurement [19]. Niswonger proposed the use of functional free space (FFS) to determine DVO. Pleasure further stated that the physiological resting position provides a stable reference for obtaining DVO [20]. Silverman suggested that VDO be determined by phonetics [21]. Pound, also in 1951, reported that phonetic tests were auxiliary methods for obtaining a reliable functional and aesthetic diagnosis. He recommended using the "s" sound, because the jaw has a vertical and horizontal positions memory when the patient pronounced the "s" sound during phonation [22]. Shanahan, in 1955, proposed using swallowing as a basis for establishing mandibular occlusal position [23].

Hull considered the validity of using radiographs to measure VDO. Cephalometric analysis would also provide the ideal orientation and position in the occlusal plane of the anterior teeth [24]. Rivera-Morales and Mohl in 1991 concluded that, as with any measurable biological aspect, VDO should not be rigid, specific, and unchangeable [25].

Misch pointed out that VDO is not a stable and accurate parameter and depends on several factors, such as head posture, emotional state, time of day, presence or absence of teeth, and parafunction [26]. Spear noted that using an occlusal splint for a period to assess the viability of a new VDO is invalid because the splint lacks natural contours, provides inadequate stability, and interferes with phonetics, although it may be useful for deprogramming the neuromuscular system and determining the maxillomandibular relationship [27].

Soft-tissue reference points are variable, and clinical methods often depend on subjective evaluation. Hard-tissue reference techniques have been assessed for VDO analysis, and software tools have been developed to support their application [28]. These approaches provide more objective measurements, reducing reliance on individual expertise. Multiple techniques using lateral telerradiographs have been described, with various cephalometric methods for estimating VDO. Some focus on the correlation between mandibular morphology (gonial angle) and the height of the lower third of the face, while others take into consideration the values specific to populations based on research involving dentate patients [29–33].

Naturally, clinicians should understand these principles and may combine them to ensure greater accuracy and meet patients' needs.

A narrative review approach was chosen to provide a broad and contextualized understanding of this complex topic, by drawing on the authors' expertise and a curated selection of relevant literature.

2. Materials and Methods

2.1. Search Strategy

This type of narrative review was chosen because of its more flexible approach, being able to provide a broader overview of VDO topic [34]. A literature search was conducted to identify relevant articles published between 1960 and 2025. The following databases were searched: PubMed, Scopus, Google Scholar, and the Cochrane Library. The search strategy used a combination of MeSH terms and free-text keywords to maximize the retrieval of relevant literature. Examples of keyword included: ("vertical dimension of occlusion") and ("dental" or "diagnosis" or "management" or "investigation" or "complications"). No language restrictions were applied initially, but only articles available in English, French, Hungarian, and Romanian were included in the final analysis.

2.2. Study Selection

The following inclusion criteria were applied to select articles for this review: (a) studies involving human subjects with issues related to the vertical dimension of occlusion; (b) studies reporting on the diagnosis, clinical features, complications, or management of the vertical dimension of occlusion; and (c) original research articles, review articles, case reports, clinical guidelines, randomized clinical trials, clinical trials, cohort studies, cross-sectional studies, case-control studies, pilot studies, and prospective and observational studies.

The exclusion criteria included: (a) studies not focused on the vertical dimension of occlusion or related conditions, (b) in vitro or animal studies, (c) studies with significant methodological limitations or biases, (d) duplicate publications, (e) lack of effective statistical analysis, and (f) abstracts, author debates, or editorials.

The study selection process involved screening titles and abstracts for relevance, followed by a full-text review of potentially eligible articles. The quality of the included studies was assessed based on the reproducibility of the methodology and the presentation of the results.

2.3. Data Extraction

Data were extracted from the selected articles using a predefined data extraction form. The following data elements were extracted: study design; sample size; patient characteristics; diagnostic methods; treatment interventions; outcomes; and key findings. A narrative approach was used for data synthesis to identify common themes, patterns, and controversies in the literature.

Due to the narrative nature of this review, a formal quality assessment of the included studies was not performed. However, when interpreting the results, the authors considered the methodological rigor of each study. Findings from well-designed randomized controlled trials with larger sample sizes and clearly defined outcomes were given greater weight. Consistency of findings across multiple studies was also considered an indicator of data reliability. Although this approach is inherently subjective, the authors strove to minimize bias by employing a comprehensive search strategy, applying consistent inclusion and exclusion criteria, consulting with prosthodontics experts, and presenting a balanced view of the evidence.

Data were collected directly from reports, when available, or from previous review studies. The main authors (A.M.C., R.M.C., and M.P.), who have more than 20 years of experience in general dentistry and oral pathology, collected data from each report independently and supervised each other's results in a rotational cycle (1 → 2 → 3 → 1). No automation tools were used. The PRISMA-style flow is displayed in Table 1.

Table 1. PRISMA-style flow diagram.

Category	Number of Articles/Studies
Records identified	163
Duplicates removed	18
Records screened	145
Records excluded	28
Full-text articles assessed for eligibility	117
Full-text articles excluded	19
Studies included in the present review	98
Studies included in qualitative synthesis	33

3. Results

The main characteristics of studies included in the current review are displayed in Table 2 (VDO assessment) and Table 3 (consequences after VDO increase).

Table 2. VDO assessment.

Authors/Year	Type of Study	Number of Participants	Sample Description	Method for VDO Evaluation	Conclusion
Domitti SS. et al. [35] 1978	Cross-sectional	380	Edentulous	Cephalometry	There is a correlation between the vertical dimension at centric occlusion and the bizygomatic distance and nasion-subnasal distance
Rugh, J.D. et al. [36] 1981	Clinical randomized	10	Dentate	Electromyography	In an upright position, certain muscles are in slight contraction to maintain the jaw in clinical rest position. What has been referred to as clinical rest position is more appropriately called upper position.
Toolson LB et al. [37] 1982	Cross-sectional	12	Edentulous	Phonetic tests	The method used to record measurements, should be evaluated by observing adequate interocclusal distance, closest speaking space, and absence of facial strain or patient discomfort.
Babu, C.L et al. [38] 1987	Cross-sectional	40	Dentate and edentulous	Electromyography	The determination of VDR by either conventional or electromyographic methods with dentures was more accurate than determining the VDR without dentures
Ferrario VF et al. [39] 1991	Cross-sectional	5	Dentate	Electromyography	Useful clinical and research tool for VDO evaluation
Edwards CL et al. [40] 1993	Cross-sectional	24	Dentate	Cephalometry	Low correlation with each subject's clinically determined occlusal vertical dimension.
Johansson A et al. [41] 1993	Cross-sectional	20	Dentate	Incisor height measurement	The distance between the gingival margins of the maxillary and mandibular anterior teeth when they are in occlusion. A distance of less than 18 mm indicates loss of VDO
Burnett CA. [42] 2000	Cross-sectional	90	Dentate	Phonetic tests—phonautograph	Phonetic tests are most usefully employed in determining that an interocclusal distance, both at rest and in speech function exist
Orthlieb JD et al. [31] 2000	Cross-sectional	505	Dentate	Cephalometry	Cephalometric analysis, despite its imperfections, may help the practitioner to understand the direction of the treatment concerning the lower facial height in occlusion
Miralles, R. et al. [43] 2001	Cross sectional	15	Dentate	Phonetic and anthropometric tests	No significant differences between swallowing and relaxed methods for free way space and VDO determination.

Table 2. *Cont.*

Authors/Year	Type of Study	Number of Participants	Sample Description	Method for VDO Evaluation	Conclusion
Gomes, V.L. et al. [44] 2008	Cross sectional	84	Dentate	Anthropometric	The distance between the outer cantus of the eye and the labial commissurae can be a reliable guide to estimate the vertical dimension of the rest position and VDO
Ladda, R. et al. [45] 2013	Cross sectional	400	Dentate	Anthropometric	The variations between VDO and finger lengths are within the range of 2–4 mm, thereby VDO prediction through this method is reliable, and reproducible
Abraham, A. et al. [46] 2015	Cross sectional	79	Dentate	Anthropometric	In class I subjects with pleasing appearance, normal facial proportions, normal overjet and overbite, and average Frankfort mandibular angle, the lower facial height (subnasale to soft tissue menton) is equal to posed smile width.
Oancea, L. et al. [28] 2020	Cross sectional	150	Dentate	Facial scanner Anthropometric Cephalometry	The facial scanning could be used for predictable registration of OVD and the stored digital information could be preserved through life and use for oral rehabilitation. However, if OVD needs to be determined, several measurement methods, including cephalometric measurements, need to be used simultaneously to reach a final decision
Lee, H.-J. et al. [47] 2011	Case report	1	Dentate	Jaw motion tracking system	The alteration of VDO can be assessed using a jaw motion device
Bacali, C. et al. [14] 2024	Cross-sectional	236	Dentate	Anthropometric	Simple formulas using finger length/palm width can be used for a rapid VDO determination.
Bhadel, R. et al. [29] 2024	Cross sectional	120	Dentate	Anthropometric	A high positive correlation between the VDO and the distance between both the right and left lateral corner of the mouth to the outer canthus of the eye, and the distance between both the right and left ear to the eye.
Fayad MI et al. [15] 2024	Cross-sectional	508	Dentate	Panoramic radiographs	The panoramic radiographs facilitated the determination of the VDO among prosthetic rehabilitation for subjects who lost vertical dimension due to loss of posterior teeth or severe wear of natural posterior teeth
Tanizaka MN et al. [48] 202	Cross-sectional	18	Edentulous	Cephalometry	Cephalometric analysis can be a method used to assist the clinical determination of VDO.
Murali Srinivasan et al. [49] 2025	Randomized	19	Edentulous	Facial scanners	Registering the resting vertical dimension in edentulous patients through digital methods may not be currently recommended

Table 3. Studies included for consequences after VDO increase (P-prospective, R-retrospective).

Authors/Year	Type of Study	Number of Participants	Sample Description	Methods for Evaluation	Amount of Increase and Period	Conclusion
Carlsson, G.E. et al. [49] 1979	P	6	Dentate	Cephalometry EMG	3–4.2 mm 7 days	A moderate increase in the vertical dimension of occlusion does not seem to be a hazardous procedure, provided that occlusal stability is established. 83% of patients fully adapted.
Burnett, C.A. et al. [50] 1992	P	6	Dentate	Sirognatograph	4 mm 5 days	Speaking space reduction
Gross MD, et al. [51] 1994	P	8	Dentate	Clinical evaluation of relaxed resting posture	3.5–4.5 mm 5 weeks	no significant difference in interocclusal rest space after increasing the occlusal vertical dimension for both clinical rest position and relaxed resting posture
Mohindra NK et al. [52] 2002	P	96	Dentate	Clinical evaluation Questionnaire	N/A 18 months	Increasing the vertical dimension of occlusion can have far reaching effects on facial aesthetics, not just on the peri-oral areas but on the whole face.
Ormianer et al. [53] 2009	R	30	Dentate Edentulous	Clinical evaluation	4–5 mm 66 months	All patients successfully adapted to the new VDO. Two patients reported tooth clenching or grinding, which abated after 2 to 3 months.
Fabbri, G. et al. [54] 2018	P	100	Dentate	Clinical evaluation	0.8–3.2 mm 12 months	Functional and prosthetic complications after the VDO increase were not frequent. Functional complications were noticed (self-reported bruxism and temporomandibular joint or muscle symptoms before treatment) but usually were no longer evident after 2 weeks.
Sterenborg BAMM et al. [55] 2018	P	44	Dentate	Facial 3D stereopho- tographs Orofacial Esthetic Scale questionnaire	1.6 ± 0.9 mm 59.9 ± 6.8 months	A full rehabilitation with an increase in VDO resulted in objective differences in facial height as measured with 3D stereophotogrammetry.
Liu, C. et al. [56] 2019	P	6	Dentate	Cone Beam Computer Tomograph	4.5–6 mm 2 years	The findings indicated that the increased OVD did not relapse to baseline and was sufficiently tolerated
Parmar DR et al. [57] 2020	P	30	Dentate	Clinical evaluation Photographs	1, 2, 3, 4 mm One session	It was found that an increase in occlusal vertical dimension led to an increase in interlabial gap height, incisal edge-to-lower lip distance, and display zone area measurements, whereas the width of smile and incisal edge-to-upper lip distance did not change with increasing occlusal vertical dimension.
Sun J et al. [58] 2021	P	25	Dentate	Clinical evaluation	3, 6, 9 mm One session	The larger the increase in OVD, the more detectable the difference and the less the faces are perceived as esthetic.

Table 3. Cont.

Authors/Year	Type of Study	Number of Participants	Sample Description	Methods for Evaluation	Amount of Increase and Period	Conclusion
Shen YF et al. [59] 2021	Prospective	40	Dentate	Swallowing tracking device (Myotronics)	2, 5, 8 mm One session	The increase in VDO could change the extent of mandibular trajectory during swallowing if the increase is more than 3 mm.
Poggio CE et al. [60] 2023	P	15	Dentate	Electromyography	2 mm One session	These results suggest that no immediate negative effect on maximum voluntary clenching was induced by a VDO increase in CR position. A slight increase observed in EMG clenching levels could be explained by the increase in VDO when clenching on the splint
Kim SW et al. [61] 2025	p	40	Dentate	Facial scans	2, 4, 6, 8 mm One session	Total face height, lower face height and nasolabial angle increased with VDO, while lip width and height decreased. For 3D-scanned facial changes, a 4-mm increase in VDO was the most perceptible difference.

4. Case Reports

4.1. Case 1

A 54-year-old female patient was referred to the Prosthodontics Department at the “Tuliu Hatieganu” University of Medicine and Pharmacy Cluj-Napoca for general dental care. The patient’s medical history revealed no contraindications to dental treatment. Patient received all information on the diagnosis and treatment plan and signed the informed consent from. The patient presented with partially edentulous spaces that had been previously restored with porcelain fused to metal fixed partial restorations. There was severe attrition of the maxillary anterior teeth, a gingival smile and reduced crown height, which suggest a possible OVD modification (Figure 1).



Figure 1. Initial aesthetic appearance: extraoral (a) and intraoral (b).

The diagnostic and treatment plan included mounting diagnostic casts on a semi-adjustable articulator with a facebow record in the centric relation position. To obtain precise information about how to intervene on this dimension, a lateral teleradiograph was performed followed by cephalometric analysis, which showed that the lower facial height was within normal limits with an angle between Anterior Nasal Spine–Center of mandibular ramus–Suprapogonion (Ans- Xi-Pm) of 43.7 (Figure 2). The laboratory technician performed a wax-up to previsualize the prosthodontic treatment.

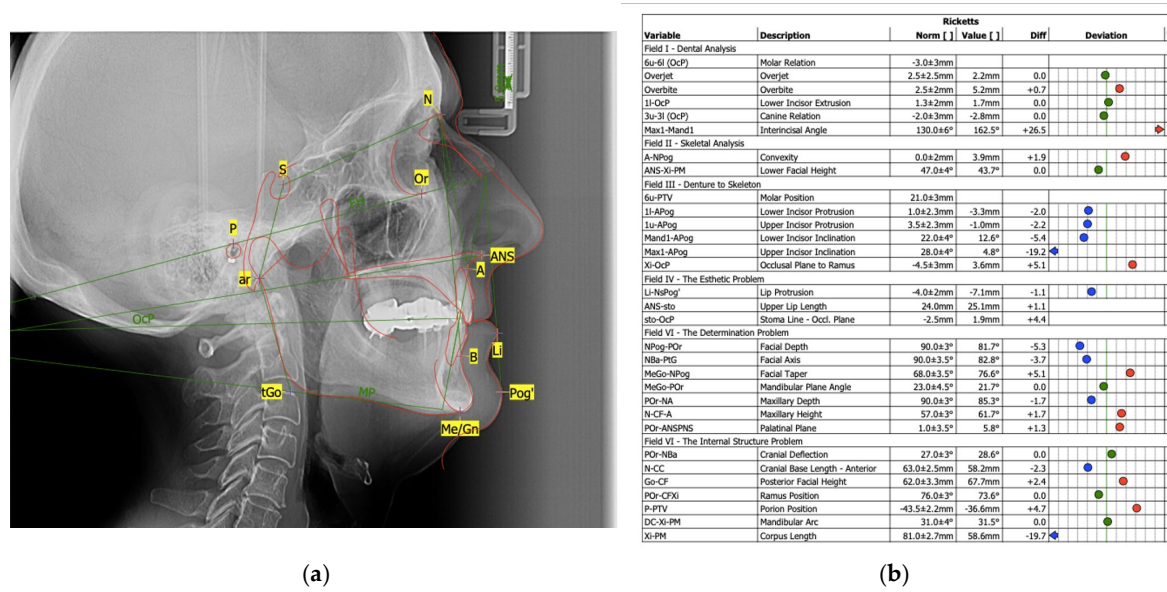


Figure 2. Radiological investigation: lateral teleradiograph (a); cephalometry (b).

Considering inferior face height value, periodontal surgery was the only option to ensure prosthodontic restorative space and to increase crown height (Figure 3), followed by temporary restorations using self-curing resin (Protemp 4, 3M Espe, Germany), with a morphology based on the wax-up.



Figure 3. Intraoral aspect after periodontal surgery.

After periodontal cicatrization, the final porcelain fused to metal restorations were fabricated (Figure 4).



Figure 4. Final aspect of prosthodontics restorations.

4.2. Case 2

A 60 year old female patient, was referred to the Prosthodontics Department at the “Tuliu Hatieganu” University of Medicine and Pharmacy Cluj-Napoca for general dental care. The patient’s medical history showed no contraindications to dental treatment. The patient received all information regarding the diagnosis and treatment plan and signed the informed consent form. The maxillary arch was partially edentulous presenting class III Kennedy edentulous spaces, that had been previously restored with porcelain fused to metal fixed partial restorations. There was severe attrition of the maxillary anterior teeth, a gingival smile and reduced crown height, suggesting a possible modification of the VDO (Figure 5).



Figure 5. Initial intraoral aesthetic appearance.

The diagnostic and the treatment plan included mounting diagnostic cast on a semi-adjustable articulator with a facebow record in the centric relation position. In this case, a lateral telerradiograph with cephalometry was also performed, to obtain precise information about VDO. The values showed that the lower facial height was slightly reduced, with an Ans-Xi-Pm angle of 42.3, allowing an increase in VDO, to create restoration space (Figure 6). The laboratory technician performed a wax-up to previsualize the prosthodontic treatment, based on the new increased VDO. The functional wax-up was then transferred intraorally using a self-curing resin (Protemp 4, 3M Espe, Seefeld, Germany), to validate the of future prosthodontic treatment (Figure 7).

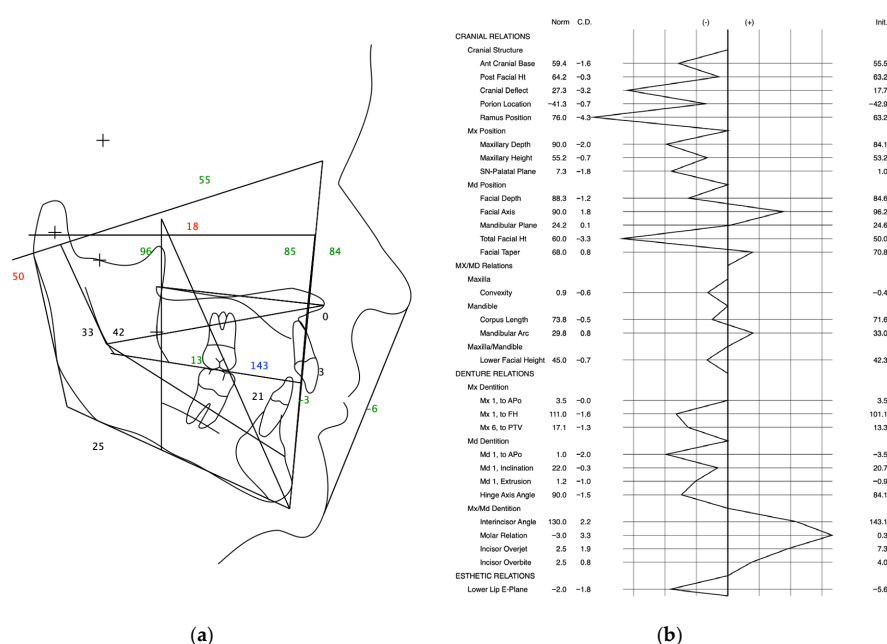


Figure 6. Radiological investigation: lateral telerradiograph (a); cephalometry (b).



Figure 7. Functional mock-up.

Following validation, the final restorations were delivered. These included ceramic lithium disilicate 3/4 veneers on the anterior teeth and zirconia fixed partial dentures in the lateral areas (Figure 8).



Figure 8. Final aspect of restorations.

5. Discussion

The current narrative review aimed at providing a broad and complex understanding of VDO analysis and treatment strategies, based on the authors' expertise and a curated selection of relevant literature.

The article includes two clinical cases that illustrate the use of cephalometric analysis for VDO evaluation. The first case presented a normal VDO, and the second presented reduced VDO. Although the clinical examination patterns were similar for both cases, the cephalometric analysis provided a more accurate evaluation of VDO values and enabled a personalized treatment plan for each patient.

Identifying, modifying or re-establishing a patient's VDO is considered one of the major challenges in prosthetic rehabilitation [62]. In healthy dentate individuals without

TMDs symptoms or tooth wear, precisely measuring their VDO is relatively unimportant, especially when compared to patients with severe attrition or complete edentulism [63].

Rather than an immutable reference, the VDO should be regarded as a dynamic dimension within a zone of physiological tolerance that can be altered if the dentist respects the envelope of function [31–34].

There are several clinical methods to evaluate and restore VDO. These methods include analyzing facial proportions, conducting phonetic assessments, and monitoring swallowing patterns [12–27].

Pre-treatment records typically rely on a visual assessment of old diagnostic models or previous photographs. While this method can approximate the loss of clinical crown height, old models are rarely available beforehand [64].

VDO is considered reduced when the distance between the gingival margins of the maxillary and mandibular anterior teeth is less than 18 mm when they are in occlusion. This method of measuring incisor height can approximate the loss of clinical crown height and can measure the severity of tooth wear. However, it can be affected by the original anterior tooth relationship [41].

Phonetic evaluations have frequently been used for VDO measurement. Pronouncing sounds such as “S” (the closest speaking space), “F” (locating the incisal edges of the anterior maxillary teeth), or “M” (locating the mandible in the rest position) are reproducible techniques used during prosthodontic rehabilitation. These techniques are more useful for constructing complete dentures but should be used with caution, as they vary for patients with Class II and III occlusions [25,37,39,42,43].

When using mandibular rest positioning for VDO assessment, the clinician can visualize the patients’ facial appearance and ensure lip competence. However, this technique must be performed with precision, as minor muscle tension will lead to inaccurate measurements [36].

Anthropometric measurements are the most appropriate technique for evaluating VDO [1–5,28,29]. Most clinicians measure the distance from subnasion (Sn) to soft tissue menton (Me’) to assess and calculate VDO. Other clinicians and researchers have indicated that the distance from pronasion (Pn) to soft tissue pogonion (Pg’) or the distance from subnasion (Sn) to soft tissue gnathion (Gn’) can also be used. A correlation has also been established between patients’ thumb and index finger lengths. Anatomical measurements related to the eyes, such as the distance from the outer canthus (OC) or the pupil to the rima oris (RO), have also been correlated. A strong correlation has been obtained between smiling width and lower facial height [14,28,29].

Cephalometric analysis is a highly accurate and reproducible radiographic evaluation method for VDO, but it requires additional equipment and involves radiation exposure. Angular measurements are typically employed, including the lower facial height (LFH) angle (ANS-Xi/Xi-Pm) and gonial angle (GA) [43–46].

Electromyography (EMG) devices determine the mandibular position at rest, when minimal muscle activity is observed. These devices are useful clinical and research tools. While they are useful for evaluating VDO, they are rarely available in dental offices, require great expertise, and recordings must be rigorously controlled [36,38].

Some methods rely on the vertical dimension at rest (VDR) as a consistent reference point. However, aging can reduce muscle tone, potentially altering the VDR [2]. Since soft-tissue reference points are unstable and clinical evaluations can be subjective, hard-tissue reference methods have been explored, with software programs developed to facilitate their application. These tools provide more objective measurements and reduce dependence on individual clinician judgment. Among these, the cephalometric technique utilizing angular

reconstruction is considered the most effective for estimating VDO in patients with natural dentition [20,21].

5.1. Treatment Options

Increasing the VDO is beneficial in restorative treatment because it creates space for reestablishing occlusal morphology and accommodating planned restorative materials. This often enables additive treatment in patients with structural loss. Minimally invasive additive treatment requires careful planning and testing with provisional restorations to evaluate the patient's adaptability [64,65]. Provisional fixed restorations with functional contours are recommended because they enable a realistic clinical evaluation of proposed VDO changes. However, provisional removable prostheses and occlusal splints are not recommended due to their instability, nonfunctional contours, and potential interference with comfort, function, and phonetics [64–66].

Alteration of morphology due to loss of hard dental tissue also causes changes in occlusal relations. Treatment options for the frontal teeth vary depending on the amount of hard tissue lost. The first option is generally minimally invasive direct adhesive solutions with composite materials, followed by a combination of direct and indirect partial restorations when a higher amount of dental tissue is lost, or full coverage prosthetic restorations. Regardless of the chosen solution, attention should be paid to the amount of material added incisally [67,68]. According to a study conducted by Prof. Galip Gurel, the risk of failure increases 2.3-fold if the incisal margin is excessively extended [69].

New treatment strategies for extensive oral rehabilitations in cases with VDO alteration have emerged, proposing minimally invasive approaches to conserve as much tooth structure as possible [70]. Due to continuous advancements in optical scanning and design technologies, the dental field has shifted toward 3D workflows [71]. Digital manufacturing technologies, along with millable wax, polymer, and ceramic blocks for computer-aided design and manufacturing (CAD/CAM), are used more frequently due to their high precision [72].

5.2. Adaptation of the Stomatognathic System to Increasing VDO

When it comes to harmonizing dentofacial aesthetics, the greater the VDO increase, the more detectable the difference and the greater the impact on aesthetics. Sun et al. [58] analyzed the perceived facial esthetics of 25 participants with Class I dental and preserved VDO who received customized mandibular devices that were digitally designed and 3D printed to increase VDO by 3, 6 and 9 mm. Three-dimensional facial scans and frontal photographs were taken. Three groups of lay people, general dentists, and prosthodontists participated in the survey and were asked to detect the VDO difference in two photographs of the same participant. Prosthodontists were the most accurate observers, detecting changes of up to 3 mm; however, the lay people only noticed the extreme changes of 9 mm.

Modifying the VDO improves TMJ function [73]. Studies indicate that in cases with associated biomechanical risks, altering the VDO is a common and safe procedure, provided that the clinician understands and respects the individual patient variables [73,74]. Abduo concluded that a permanent increase in VDO of up to 5 mm is safe and predictable when indicated. Self-limiting associated signs and symptoms typically resolve within two weeks [75]. Moreno-Hay and Okeson stated that the stomatognathic system can rapidly adapt to moderate VDO changes [76]. Some patients may experience mild, transient symptoms, but these are generally self-limiting with no major consequences. No evidence has been found between permanent alteration of the VDO and long-term temporomandibular dysfunction [77–79].

5.3. How Do You Determine the Extent of Modification?

Modification extent is determined by considering multiple factors: Angle classification and skeletal typology; adherence to the treatment preview steps; validation through provisional restorations; and observance of the rule of thirds when making articulator modifications. Specifically, increasing the incisal pin level by 3 mm results in increases of 2 mm at the molar level and 1 mm at the temporomandibular joint (TMJ) [59,80,81].

“Prosthetic compensation” should only be used as a last resort due to compromises associated of each form of compensation. Whenever indicated, orthodontic and orthognathic treatment should be recommended. A significant VDO increase is limited because the lingual surface of the anterior teeth may become excessively thick, impairing anterior contacts and physiological contours. For example, according to this rule, increasing VDO by 6 mm at the incisal pin for Class I Angle patients would make the lingual surface of the anterior teeth approximately 4 mm thicker vertically. This would likely result in aesthetic, functional, comfort, and speech issues. For Class II patients, the situation is even more problematic, because it becomes nearly impossible to establish stable and adequate anterior contacts due to increased mandibular rotation and sagittal discrepancy [81,82].

In order to best adapt prosthetic restorations, restore affected functions, and reestablish harmony in the lower third of the face, it is necessary to consider each patient’s morphology when analyzing anthropometric marker changes induced by complex prosthetic rehabilitations [83].

By analyzing both commonly observed changes and changes specifically influenced by skeletal typology following comprehensive prosthetic rehabilitation, it has been found that while some modifications are manageable, others require close and continuous clinical monitoring [81–83].

Future research on the complex topic of VDO should focus on establishing a standardized analysis protocol and proposing the most suitable materials for provisional and definitive restorations. It should also provide details about the evaluation phase duration.

6. Conclusions

The therapeutically designed OVD should be considered as a flexible parameter within a biological tolerance range rather than a rigid reference point. To ensure predictable results and minimize risks, changes should be kept to a minimum to achieve dentofacial aesthetic harmony and secure adequate space for the planned restorations.

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