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CASE REPORT

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Complete morphofunctional oral rehabilitation by physiological increase of occlusal vertical dimension according to computerized mandibular scanner

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Abstract

Increasing the occlusal vertical dimension (OVD) is often indicated in complex oral rehabilitation to gain restorative space and improve the occlusal relationship and aesthetics. The effect of increasing the OVD on lower facial height and facial aesthetics is not well understood and evaluated. The authors present the philosophy of the neuromuscular concept and illustrate it through a case report of a 58-year-old female patient who presented severe deep bite, bruxism, and temporomandibular disorders (TMDs). After clinical evaluation, the extraoral examination showed a reduction of the lower facial height, protuberant lips, wrinkles, and over-closed commissures. In addition, intraoral examination showed a severe anterior deep bite articulation, and the upper incisors completely covering the lower incisors labial surfaces. Through the philosophy of the neuromuscular concept the diagnostic ability, the quality and stability of the treatment increases. A temporary long-term fixed prosthesis was made at the enlarged OVD to be used in the first stage of the rehabilitation. Compared to the initial situation, the new prosthesis was delivered at a vertical dimension (VD) higher with 7 mm. The purpose of the neuromuscular philosophy and methodology is to harmonize the facial profile, functional occlusion, the joint function, and neuromuscular control. Through the neuromuscular methodology, we can assess the patient's ability to manage a significant increase in VD and to restore a functional OVD by physiological measurements.

Keywords: occlusion, occlusal vertical dimension, increasing occlusal vertical dimension, freeway space, oral rehabilitation, clinical evidence.

Introduction

Partial edentulism and several dentofacial abnormalities are associated with significant changes in intermaxillary relationships, of which the reduction in occlusal vertical dimension (OVD) is the most obvious and most difficult to correct. Oral rehabilitation aims to restore the integrity of dental arches with the restoration of all physiological components of the stomatognathic system (SS) and implicitly with the restoration of all its functions. Within the SS functionality, an important element is the vertical dimension (VD) of the lower face. OVD and rest vertical dimension (RVD) are important in dental practice, depending on which prosthetic restorations are performed. Several anthropometric and functional methods have been used to determine the vertical size of the lower face, but their accuracy is controversial. There are studies showing that there is no single OVD, but there is an area of muscle comfort that corresponds to optimal SS functionality [1].

The computerized mandibular scanner (CMS) together with transcutaneous electrical nerve stimulation (TENS) and surface electromyography (sEMG) is a method by which the muscular balance can be restored, and therefore the OVD corresponding to the functional rest position can be determined. Oral rehabilitation relies on the clinical application of the available evidence regarding interocclusal distance (IOD), the steadiness of RVD, and the consequences of altering the patient's OVD [2].

Patients in need of extensive oral rehabilitation may require restoration of their OVD because of tooth wear [3], tooth loss, or deterioration of existing prostheses over time which can lead to important periodontal clinico-morphological changes [4, 5]. Oral rehabilitation should grant once more a state of functional and biological efficiency by harmonizing the complexity of each structure: teeth, periodontium, the masticatory muscles, and the temporo-mandibular joint (TMJ) mechanisms. For dentate individuals, the OVD is largely determined by the occluding dentition [6]. Subsequently, the OVD changes lead to alteration in facial morphology, function, comfort, and esthetics [7]. For generalized loss of crown height due to tooth wear or deterioration of previous prosthesis, from the clinical and technical perspective, it is useful to consider increasing the OVD since it will provide the needed space for restorative material, enhance the esthetic tooth display, correct anterior teeth relationship, restore the physiological occlusion, and minimize the necessity for biologically invasive clinical procedures, such as crown-lengthening surgery and elective endodontic treatment [8–11].

Neuromuscular dentistry (ND) can be defined currently as a diagnostic and treatment procedure in which the teeth, TMJ, and masticatory muscles are considered simultaneously [12]. Dr. Bernard Jankelson introduced this methodology in the late 1970s [13–18]. ND involves multiple quantitative and qualitative measurements and procedures, including mandibular tracking, sEMG, and TENS. The use of ultra-low frequency (ULF)–TENS relaxing occurs relatively rarely in the dental clinic. Alongside financial barriers to the acquisition and use of the technology, the infrequent use of ULF–TENS may be due to a lack of information within dental communities about the importance of muscle relaxation, and the consequential changes in the spatial relationship between the cranium and the mandible [19–22].

Aim

The aim of this case report was the presentation of a clinical case in which an oral rehabilitation was performed based on the determination of the muscle comfort zone corresponding to an OVD that would allow the optimal functionality of the SS, using CMS and sEMG.

Case presentation

The authors present the philosophy of the neuromuscular concept and illustrate it through a case report of a 58-year-old female patient who presented severe deep bite due to a failed prosthetic treatment and temporomandibular disorders (TMDs).

The first visit was in fact a virtual one, the patient, providing preliminary photos and some X-rays (Figure 1, A–E; Figure 2), considering that her chief complaint was severe headache resistant to all common painkillers. After accepting our approach, considering her state of discomfort, the patient came in our Clinic to receive a pain relief treatment.

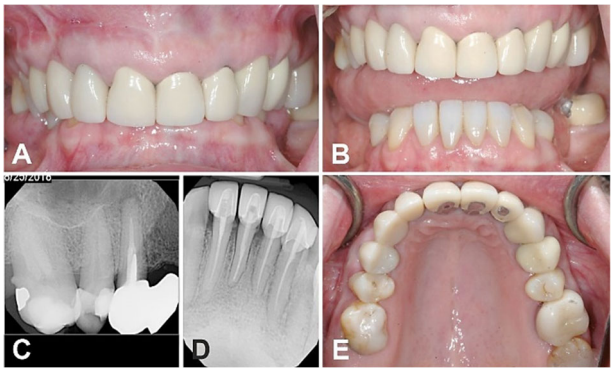

Figure 1 – ***(A–E) Initial intraoral pictures and X-rays of the patient provided during the primary virtual consultation.***

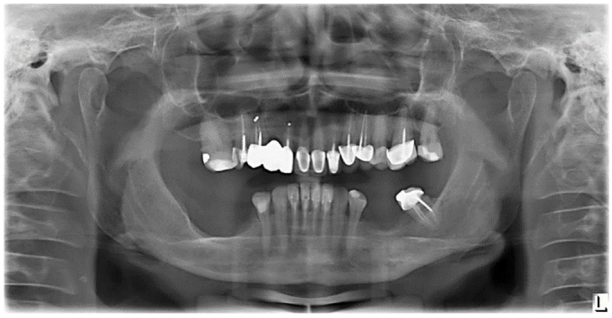

Figure 2 – ***Initial panoramic X-ray.***

Initial examination

According to protocol, we filled the anamnestic form, and the patient received the preliminary treatment plan for surgery, endodontics, restorative, and prosthodontics procedures to be performed for which she signed the clinical consent alongside with the permission for the photo and video documentation. A new panoramic X-ray led to the decision that more detailed information was necessary, so a computed tomography (CT) scan was required to evaluate the overall situation. The full cone-beam computed tomography (CBCT) taken to establish the possible teeth to be saved through endodontic treatment was useful also for the primary evaluation of the bone loss (Figure 3, A–E).

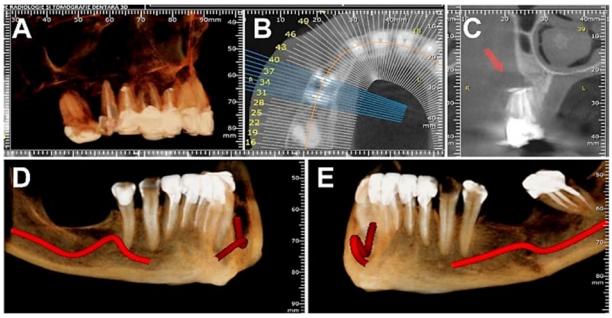

Figure 3 – ***CBCT scan: (A) Lateral view upper right quadrant; (B) Axial view of the upper right quadrant; (C) 24-section showing an important bony defect after apicectomy; (D) Right and (E) left important mandibular bone resorption. CBCT: Cone-beam computed tomography.***

At clinical evaluation, the extraoral examination showed a reduction of the lower facial height, protuberant lips, wrinkles and over-closed commissures, and an overall depressive appearance (Figure 4).

Figure 4 – ***Initial extraoral aspect in frontal and lateral views.***

In addition, intraoral examination showed a severe anterior deep bite articulation with the upper incisors completely covering the lower incisors labial surfaces, worn dentition and a failed and consumed partial lower denture. Huge VD loss and failed prosthetic treatment both on upper and lower arches, the severely grinded upper incisors, lower anterior teeth consumed and tilted inwards (the ceramic was absent on the zirconia restorations) and worn partial denture could be observed (Figure 5, A–E).

Important discrepancy between the patient's age and facial expression and pronounced labio-mental and naso-labial folds announcing a deep bite with a severe OVD loss were revealed.

Initially, an alginate impression for casting the stone models and an addition silicone impression for in-office

immediate provisional restorations were taken and a lateral teleradiography at preoperative position was also made (Figure 6).

Having the patient assume a relaxed position, the rest position showed important tongue compensation (Figure 7). The Myotronics K7 Evaluation System analysis was proposed to the patient for establishing a correct starting point for the future full mouth rehabilitation. Moreover, the upper central crowns were removed, and a layer of light cure base plate was applied over the lower denture (Figure 8, A and B). Noting the deep bite, the lower denture was transformed by adding a layer of light cure denture base material (Figure 8C), which was intended to have a reduced quantity of bite registration silicone while transferring the myocentric position and starting the CMS and sEMG registration (Myotronics, Inc., Kent, WA, USA) (Figure 9).

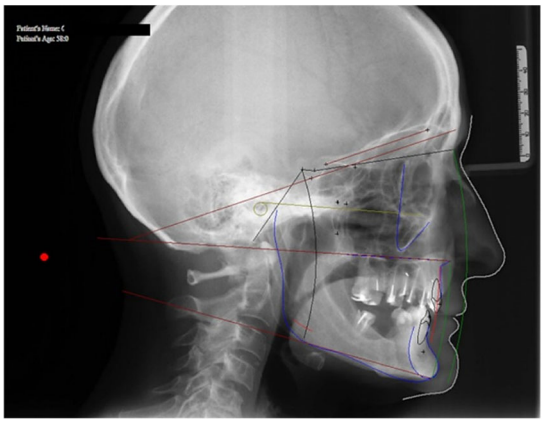

Figure 6 – ***Initial lateral teleradiography overlayed with Sassouni measurements.***

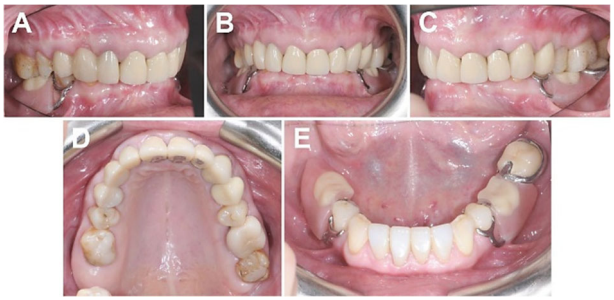

Figure 5 – ***Intraoral aspect: (A) Lateral occlusion right; (B) Frontal occlusion; (C) Lateral occlusion left; (D) Occlusal view of the upper arch; (E) Occlusal view of the lower arch.***

Figure 7 – ***View of the tongue compensation.***

Figure 8 – ***(A) Initial position; (B) Myocentric occlusal registration; (C) View of the lower denture with the applied layer of light cure composite base plate Individo Lux (Voco GmbH, Germany) and the occlusion A-silicone Occlufast (Zhermack SpA, Italy).***

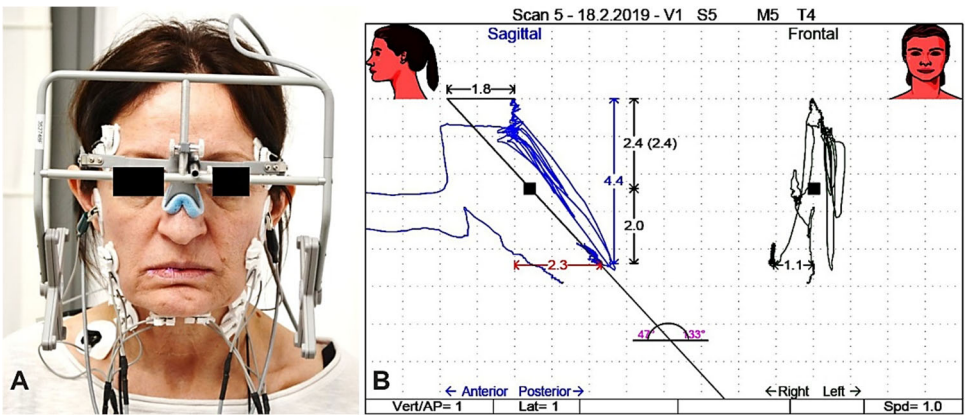

Figure 9 – ***(A) Patient with Myotronics K7 system mounted; (B) Initial myocentric occlusal registration on sagittal and frontal trajectory.***

Treatment

The facial arch transfer was executed with the Artex facebow (Amann Girrbach AG, Koblach, Austria) (Figure 10).

The unmounting of existing crowns was performed and a step-by-step procedure of tooth reduction while relining the myocentric occlusion, to preserve the newly obtained occlusal dimension. The hopeless teeth were cut at gum

level before polyvinyl siloxane (PVS) impressions and bisacrylic temporaries replicating the initial status where cemented. While waiting for the lab work, the endodontic treatment was performed on several teeth (1.6, 1.1, 2.1, 2.5, 2.7, 4.4, 4.3, 3.4, 3.3).

A week later two full arch milled fiber reinforced composite structures Trilor™ (Bioloren Srl, Saronno, VA, Italy) with acrylic resin injected teeth were delivered (Figure 11, A–C).

The extractions of 1.2, 1.4, 2.6 and subsequent relining were done two days after the installation of the provisional restorations and a second Myotronics K7 registration was performed. Soft silicone night guards were produced after alginate impressions taken of latest situation before the patients returning to her home country.

Six months later, the patient returned to our Clinic to finalize the remaining teeth (4.1, 4.2, 3.1, 3.2) to be treated endodontically; the reconstruction of the teeth with fiber posts and dual cure resin cement and the extraction of 2.2 with subsequent relining were also done. The control CMS and sEMG were performed showing a stable result (Figures 12 and 13). Lateral teleradiography, TMJ and panoramic X-rays were also performed to evaluate current status (Figure 14).

Although implant surgery and bone reconstruction were proposed, the patient postponed the treatment due to financial issues and most importantly because she felt great with the current result. Through the philosophy of the neuromuscular concept the diagnostic ability, the quality and stability of the treatment increases. A temporary long-term fixed prosthesis was made at the enlarged OVD to be used in the first stage of the rehabilitation. Compared to the initial situation, the new prosthesis was delivered at a VD higher with 7 mm (Figures 15 and 16).

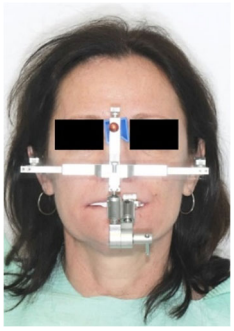

Figure 10 – ***Face-bow transfer Artex (Amann Girrbach AG, Austria).***

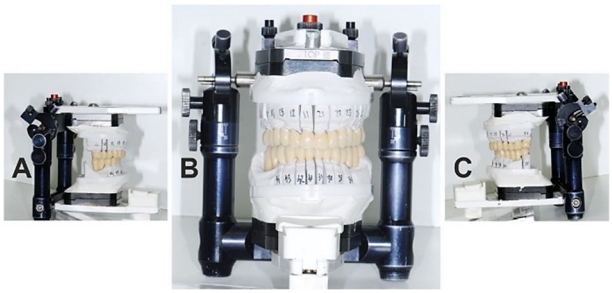

Figure 11 – ***(A–C) The 2-full arch milled fiber reinforced composite structures Trilor™ (Bioloren Srl, Italy) with acrylic resin injected teeth.***

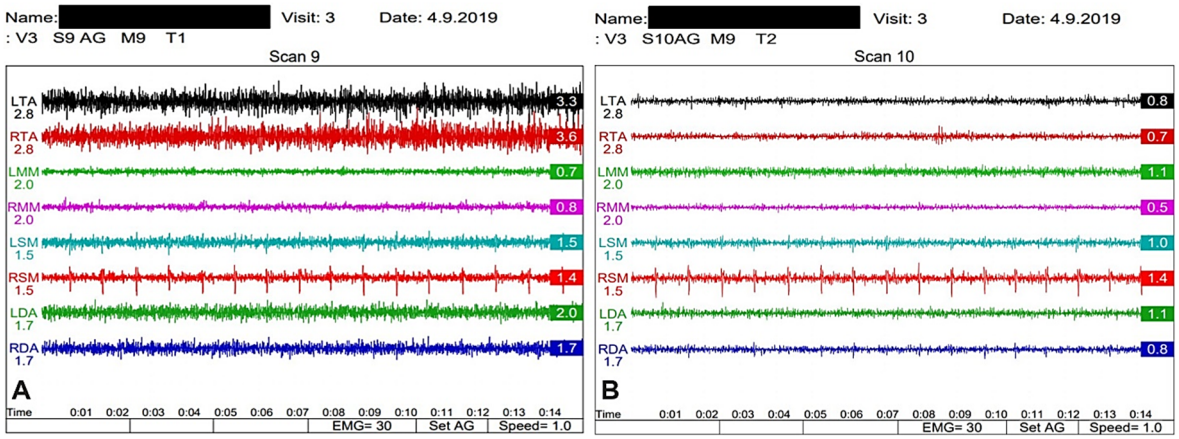

Figure 12 – ***Control EMG showing overall muscular relaxation: (A) Before TENS; (B) After TENS. EMG: Electromyography; TENS: Transcutaneous electrical nerve stimulation.***

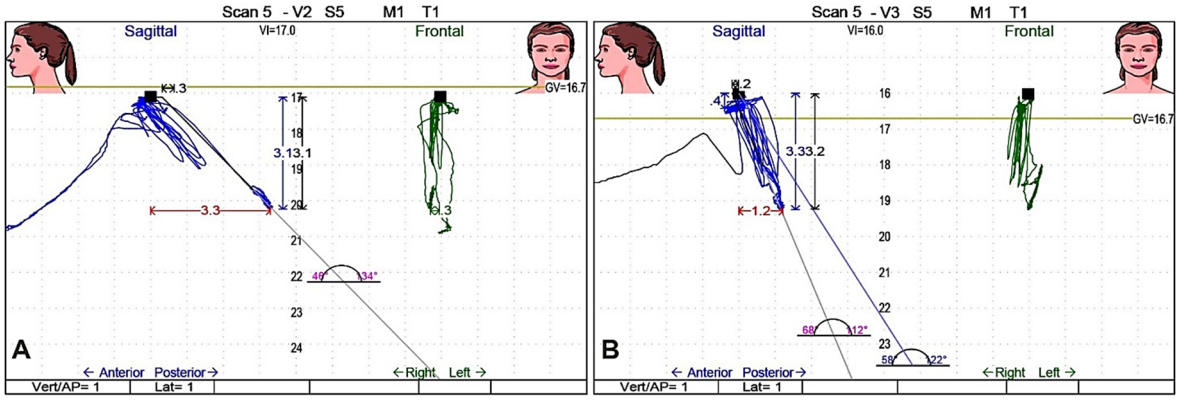

Figure 13 – ***(A) Initial CMS after provisional installation; (B) Control after six months showing the stable result. CMS: Computerized mandibular scanner.***

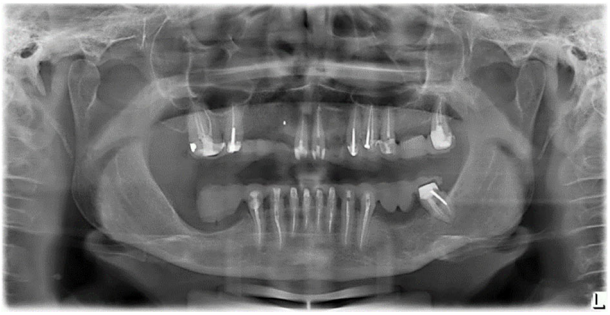

Figure 14 – ***Panoramic X-ray after current treatment phase.***

Figure 15 – ***Smile of the patient after (first row) and before (second row) treatment.***

Figure 16 – ***Detailed view of the delivered long-term provisionals in frontal occlusion: (A) Normal view; (B) 45-degree incisal view.***

Discussions

CMS and sEMG of jaw muscles are important diagnostic tools in the complete morphofunctional oral rehabilitations requiring an increase of the OVD [23–26]. The permanent increase of the OVD is a safe and predictable procedure and rehabilitation with a fixed restoration is more predictable and results in a higher adaptation level [26–28].

Increasing OVD has been considered by some authors to be a hazardous procedure that can violate a patient's dental physiology and adaptation [29, 30]. Dysfunctional occlusion may lead to a great variety of changes in all the components of the SS from TMJ to periodontal structures [31]. Abduo [26], in a systematic review of nine articles that met the inclusion criteria, concluded that, where indicated, a 5 mm increase in the OVD "is a safe and predictable procedure without detrimental consequences". His concern over the heterogeneity of the experimental design, the inclusion of healthy participants that typically would have no treatment and participants with worn dentitions, combined with the small number of participants necessitated more high-quality clinical studies.

Neuromuscular occlusion is in harmony with relaxed, healthy muscles and properly functioning TMJ. It is a stable maxillo–mandibular position of dental occlusion arrived at by isotonic contraction of relaxed masticatory muscles, achieved by stimulation of those muscles on a trajectory (arc) beginning at a muscularly rested mandibular position [32]. Healthy TMJ function must be accompanied by a stable dental occlusion, freely entered, and exited without interferences, dictated by, and directed by healthy relaxed masticatory muscles for long-term stability of all the inter-related structures.

Joints do not initiate or dictate function; they permit function and adapt to functional demands. Healthy TMJ function is not primary, but secondary to a physiological dental occlusion. Form follows function: the shape of hard structures results from the function which they are required to perform [33]. To protect the hard structures (joints, alveolar bones), healthy function must be provided to the soft tissues (muscles, periodontium, and ligaments). Hence, it is valuable to analyze function before form to understand how and why anatomical form was changed. For example, it is valuable to analyze the genesis of the severe attrition seen on incisor teeth prior to treatment planning for porcelain laminate veneers, or the same conditions untreated can cause failure of the new restorations. The concept of a neuromuscular dental occlusion has not changed since its introduction in 1973; only the technology used to establish this therapeutic occlusion has been developed and refined [13].

It is an accepted physiological axiom that muscles function optimally from their full resting length: a rested state [33]. Implementation of the recognition of the essential role of relaxed masticatory muscles as a prerequisite for the establishment of an ergonomic, optimally physiological occlusion was the impetus for the development of an instrument capable of affecting true physiological masticatory muscle relaxation. The clinical device developed to relax mandibular elevator and depressor muscles is a neuro-muscular stimulator that delivers an intermittent minute, low voltage, low amperage, fixed rate neural stimulus simultaneously to all the masticatory muscles through the mandibular division of the trigeminal nerve applied over the mandibular coronoid notch [18, 34–36]. The stimulator used is like other medical nerve mediated ULF–TENS devices used to affect relaxation of muscles. In the case of TMD, the mandibular elevator and depressor muscles are the stimulated muscles [37–40]. Proper diagnosis of any medical/dental condition is made by the treating doctor and begins with obtaining a history of the illness and performing a comprehensive clinical examination of the affected area, employing imaging studies when indicated. The diagnostic process and treatment plan are greatly enhanced using technologies that can scrutinize the anatomic and functional components of the masticatory system, providing reliable and precise objective measurement data. Because of the diversity of structures involved and variability in chronicity and intensity of TMD presentations between patients, there can be no single diagnostic test with an acceptable level of "specificity" to rule TMD in or out. In medicine, there are many devices considered valuable as diagnostic aids, such as radiographs, magnetic resonance imaging (MRI), and cardiac stress tests that are not free-standing diagnostic devices.

Sometimes, more than one device is used to obtain a proper diagnosis. Within the past four decades, three computerized measurement devices have been developed and refined to record and analyze, with high degrees of precision, masticatory muscle function (EMG), mandibular movements (CMS), TMJ sounds [electrosonography (ESG)], and dental occlusion as dynamic phenomena [41].

Conclusions

Since the clinical techniques to assess OVD loss are of limited predictability and reliability, they cannot be used to estimate the magnitude of increasing OVD. Likewise, facial morphology cannot be used as a guide for increasing OVD. Instead, an increase in OVD should be determined based on the need to accomplish satisfactory and aesthetically pleasing restorations. The factors that should be considered as determinants for increasing the OVD are the remaining tooth structure, the space available for the restoration, occlusal variables, and aesthetics. Minimizing the increase in OVD is useful to reduce the overall complexity of the oral rehabilitation. Increasing OVD by more than 7 mm is rarely indicated. However, increasing OVD is a safe procedure, and any consequential signs and symptoms tend to be self-limiting. Through the neuromuscular methodology we can assess the patient's ability to manage a significant increase in VD and to restore a functional OVD by physiological measurements.

Conflict of interests

The authors declare that they have no conflict of interests.

Authors' contribution

FEC performed therapy on the patient. All authors analyzed treatment outcome; FEC and MVC drafted the manuscript. All authors revised the manuscript and approved the final version of the manuscript.

Financial disclosure

There are no financial supports. This case report received no specific grant from any funding agencies.

Ethical approval

Since there is a case report, no ethics are required.

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