

Altered Vertical Dimension of Occlusion: A Comparative Retrospective Pilot Study of Tooth- and Implant-Supported Restorations

Zeev Ormianer, DMD¹/Ady Palty, DMD²

Purpose: Altering the vertical dimension of occlusion (VDO) by increasing the interarch distance is common in oral rehabilitation, but little is known about the ability of implant patients, who lack sensory perception in implanted regions, to adapt to such changes. This study sought to evaluate the outcome of increasing VDO in patients restored with implant-supported fixed restorations opposed by restored natural teeth or implant-supported restorations. **Materials and Methods:** VDO was increased by 3 to 5 mm to address the individual prosthetic needs of 30 patients. Group A (control) consisted of 10 patients with fixed restorations on natural dentition that opposed the natural dentition in a new VDO relationship. Two test groups consisted of 10 patients each, with fixed implant-supported restorations opposing either the restored natural dentition (group B) or fixed implant-supported restorations (group C). After an average follow-up of 66 months, marginal bone changes were calculated using standardized periapical radiographs, and mechanical prosthetic maintenance data were collected from patient files. The results were analyzed using Kruskal-Wallis one-way analysis of variance to identify significant differences between the groups. **Results:** All patients successfully adapted to the new VDO. Two patients in group B and four in group C reported tooth clenching or grinding, which abated after 2 to 3 months ($P < .05$). More bone loss and tooth failures were observed in group A, and more mechanical complications, such as porcelain fractures, were observed in group C ($P < .05$). **Conclusion:** Within the limitations of this study, alteration of VDO was an acceptable procedure in patients with implant-supported fixed restorations, but precautions should be taken to prevent mechanical problems. *INT J ORAL MAXILLOFAC IMPLANTS* 2009;24:497-501

Key words: dental implants, occlusion, teeth, vertical dimension of occlusion

The vertical dimension of occlusion (VDO) is defined as the distance measured between two points when teeth are in light occlusal contact.^{1,2} Traditionally, it has been maintained that increasing VDO may cause an elevation in bite force,³⁻⁷ muscle hypersensitivity, and symptoms of temporomandibular disorders (TMD). Currently, alteration of VDO by increasing the interarch distance is frequently performed in oral rehabilitation to enhance esthetic tooth display, improve lip support, establish anatomic harmony, and improve phonetics.^{1,2} Proper occlusal adjustment with occlusal devices will reduce muscle tenderness and TMD symptoms.³⁻⁷

A patient's adaptation to the new resting posture is controlled by neuroreceptors located in the periodontal ligament (PDL), the masticatory mucosa, and temporomandibular joint. While there is little published research on the ability of patients with implant-supported restorations to adapt to new VDO relationships, it is known that an increase in bite force⁸⁻¹² and PDL deficiency¹³⁻¹⁸ are two consequences of implant-supported restorations. Together these factors may reduce a patient's ability to accommodate VDO changes and adversely affect survival of the implants and the restoration.

Some studies on implant loading have reported that the threshold for generation of action potentials from implant loading is higher than for the adjacent natural teeth.¹⁹⁻²² Increased bite force and reduced sensory perception may lead to implant overload. Bone loss, TMD symptoms, or mechanical problems such as screw loosening and occlusal material fractures may occur and cause failure of the restoration or amplify the maintenance requirements for implant patients.

¹Private Practice in Prosthodontics and Implant Dentistry, Ramat Gan, Israel.

²Clinical Professor, College of Dentistry, David B. Krises Dental Center, New York University, New York, New York.

Correspondence to: Dr Zeev Ormianer, 143 Bialik Street, Ramat-Gan 52523 Israel. Email: drzeev@ormianer.com

This study evaluated the effect of increasing VDO in patients with fixed implant-supported restorations that were opposed by either restored natural teeth or implant-supported restorations.

MATERIALS AND METHODS

This was a nonrandomized, uncontrolled, retrospective study examining the clinical outcome of increasing VDO in patients who needed either implant- or tooth-supported fixed partial dentures (FPDs). Study candidates were selected from the patient directory of the first author's private practice. Indications for alteration of VDO included tooth wear, excessive vertical overlap in the anterior zone, and the need to establish esthetic tooth display, lip support, and anatomic harmony. Data from 30 subjects were collected for the study and assembled into three groups of 10 patients each based on their prosthodontic needs: group A (control) required tooth-supported FPDs to oppose natural dentition, group B (test group 1) required implant-supported restorations in the maxilla opposing a restored natural dentition, and group C (test group 2) required implant-supported FPDs to oppose fixed implant-supported restorations. The periodontal status of the remaining dentition in groups A and B was defined as controlled adult-type periodontitis. All patients received care from an oral hygienist every 6 months.

A diagnostic workup was performed to evaluate the functional and esthetic needs of each case and the desires of the patient. A study cast was fabricated and mounted on a semiadjustable articulator (Quick Master, F.A.G. Dentaire, Cluses, France) using a facebow (Quick Master Facebow, F.A.G. Dentaire) transfer and interocclusal registration to determine the jaw relationships, available occlusal dimension, proposed implant positions (when applicable), crown-root ratios, and possible complications. This allowed creation of a prosthetic wax trial denture and, for test group patients (B and C), fabrication of a surgical template to guide placement of the implants relative to the planned prosthesis.

In test groups B and C, osteotomies were prepared sequentially with the surgical template and under copious irrigation according to the implant manufacturer's protocol. Tapered screw implants with triple lead threads and microtextured surfaces (Tapered Screw-Vent MTX, Zimmer Dental Inc, Carlsbad, CA) were delivered to the prepared sites and subjected to a conventional 3- to 6-month submerged healing period. Prosthetic restoration commenced after stage-two surgery and soft tissue healing.

In group B, patients received 8 to 11 implants in the maxilla to support 12-unit FPDs. In group C, patients received 14 to 19 implants in both arches to support 9- to 12-unit FPDs. One patient had 8 implants in the maxilla supporting a 10-unit FPD; this opposed a 9-unit FPD supported by 6 implants.

In all three groups, acrylic resin FPDs (Unifast, GC America Inc, Alsip, IL) were fabricated from the prosthetic wax trial dentures. VDO was increased by a range of 3 to 5 mm, measured in the premolar region with a caliper, to address the individual prosthetic needs of each patient.

In group A, all the teeth were prepared in both arches and the acrylic resin FPDs were relined on the patient's dentition. The new VDO was established during the same appointment. In all group A patients, the FPDs were supported with no fewer than 10 abutments without cantilevers, and the pontics replaced only one adjacent missing tooth.

In groups B and C, impressions were made at the implant level. The working models were mounted in a semiadjustable articulator. The diagnostic wax trial denture was converted to an acrylic resin restoration on the definitive implant abutments.

In all groups a controlled prosthetic method, the Cross Mounting Technique,²³ was used to deliver restorative data to the dental laboratory. Provisional and definitive restorations were cross arched and splinted. The occlusal contacts were cusps to marginal ridge, and lateral excursions were established in the molar and premolar regions. The acrylic resin FPDs were replaced with porcelain-fused-to-metal FPDs after 3 months of functioning at the new VDO.

Patients were monitored annually for 3 to 11 years. Marginal bone level changes were calculated from the cemento-enamel junction or from the implant neck to the bone level using periapical radiographs obtained at implant placement and all subsequent appointments using a standardized parallelizing device. Mechanical prosthetic maintenance data were collected from patients' files and evaluated clinically. The results were analyzed using the Kruskal-Wallis one-way analysis of variance to identify significant differences between the groups.

RESULTS

All patients (n = 30) adapted to the new VDO without any signs or symptoms of TMD or disruption of phonetic quality. The average cumulative follow-up period for all groups was 66 months.

In group A (Table 1), 245 teeth were restored in both arches and monitored for an average of 7 years.

Table 1 Control Group A (Teeth Opposing Teeth): Patient Data and Adverse Event Summary

Parameter	Patient no.									
	1	2	3	4	5	6	7	8	9	10
Follow-up time (y)	4	8	5	5	6	10	6	7	8	11
Patient age (y)	59	46	52	46	63	55	45	60	45	67
No. of teeth restored	26	26	21	28	26	22	22	24	24	26
Mean bone loss (mm)	2	1	2	0	2	4	1	5	1	4
No. of porcelain fractures	1	1	0	0	0	0	0	0	0	1
No. of cement washouts	1	0	0	1	0	0	0	0	1	0
No. of post-and-core failures	0	1	0	0	0	0	0	0	0	0
No. of tooth failures	3	0	0	3	2	1	0	0	2	1
TMD symptoms present?	No	No	No	No	No	No	No	No	No	No

Table 2 Test Group B (Implants Opposing Teeth): Patient Data and Adverse Event Summary

Parameter	Patient no.									
	1	2	3	4	5	6	7	8	9	10
Follow-up time (y)	6	4	3	6	5	3	6	3	4	5
Patient age (y)	55	53	52	62	67	63	65	42	70	60
No. of teeth restored	14	14	14	12	12	12	14	12	14	14
No. of implants restored	8	8	11	8	8	8	9	8	9	8
Mean bone loss at teeth (mm)	4	3	3	2	1	0	3	0	2	2
Mean bone loss at implants (mm)	0	0	0	0	0	0	0	0	0	0
No. of porcelain fractures	0	0	0	0	0	0	0	0	0	0
No. of cement washouts	1	0	0	0	0	0	0	0	1	0
No. of post-and-core failures	0	1	0	0	0	0	0	0	0	0
No. of tooth failures	0	0	0	1	0	1	0	0	0	0
TMD symptoms present?	No	Yes	No	No	No	No	Yes	No	No	No

Table 3 Test Group C (Implants Opposing Implants): Patient Data and Adverse Event Summary

Parameter	Patient no.									
	1	2	3	4	5	6	7	8	9	10
Follow-up time (y)	8	6	8	6	6	3	4	4	3	3
Patient age (y)	45	50	25	44	47	60	60	55	50	55
No. of implants restored	15	17	15	19	19	14	15	15	14	19
Mean bone loss (mm)	3	2	0	2	3	0	1	0	1	0
No. of porcelain fractures	2	1	0	0	0	1	1	1	0	0
TMD symptoms present?	No	Yes	No	No	No	No	Yes	Yes	No	Yes

Average bone loss was 2.3 mm. Twelve teeth were extracted as a result of caries, periodontitis, or tooth fracture. More tooth failures and cement washouts were detected in posterior segments, but more post-and-core failures and porcelain fractures occurred in anterior teeth.

In group B (Table 2), a total of 128 teeth and 85 implants were restored in both arches and monitored for an average of 4.5 years. Mean bone loss was 2 mm and primarily occurred around posterior teeth

rather than around implants. Two teeth failed, and there was one case of cement washout and one case of porcelain fracture. Two patients also reported that they began grinding their teeth after delivery of the definitive restoration, but this parafunction abated after 2 to 3 months.

In group C (Table 3), 162 implants were restored in both arches and monitored for an average of 5.1 years. Mean bone loss was 2 mm, which primarily occurred in the posterior arch segments on the buccal

aspect of the implants. No screw loosening or abutment screw fractures were reported. Six incidences of porcelain fracture were found, mainly in the anterior segments ($P < .05$). Four patients reported tooth clenching during adjustment to the new VDO ($P < .05$) and were treated with an occlusal device. The symptoms ceased after the device had been used for 3 months. Signs of grinding on excursive movements were found on the device, and occlusal adjustments were performed to distribute the path of motion to the molar-canine region. The patients reported symptom relief and the clinician recommended continued use of the device.

DISCUSSION

While long-term predictability is a key objective in implant therapy,^{14,15} prosthodontic maintenance events may occur over time. A comprehensive meta-analysis of all English-language implant studies published between 1981 and 2001 found a 6% to 7% incidence of abutment/prosthesis screw loosening and rate of porcelain or acrylic resin tooth fractures above 14% for dental implant restorations in general.¹⁸ These findings have not appeared to change in more recent studies¹⁴⁻¹⁸ and may be especially high for screw-retained restorations in edentulous patients.^{14,15} The two major maintenance requirements—broken gold or abutment screws and fractured denture teeth—may have been attributable in some studies to the narrow prosthetic platform and limited interfacial contact provided by the implant system's external hexagonal connection, which reportedly lacked adequate resistance to rotational micromovement and tilting by the abutment during functional loading.²⁴⁻²⁷

Although not specifically mentioned in these articles, it may be assumed that alteration of the VDO was part of the prosthetic treatment, especially when patients were converted from tissue-supported to implant-supported restorations. Such prosthodontic alteration of the VDO^{2,8-12} and a shift from tissue- to implant-supported restorations⁸⁻¹² have been reported to elevate bite force and thus increase the force of implant loading, which may adversely affect the long-term survival of both the restoration and the implants. Occlusal overloading has been cited in the dental literature as a leading cause of peri-implant bone loss, abutment and prosthesis screw loosening, loss of osseointegration, and/or fractures within the implant-restorative complex.²⁸⁻³¹

PDL deficiency may also reduce a patient's ability to accommodate these changes. The function of PDL mechanoreceptors is to mediate tactile sensibility of

the teeth and related sensory functions, such as oral stereogenesis, jaw opening reflex, and limitation of maximal clenching forces. Studies on implant loading have reported sensory perception thresholds 10 to 100 times higher than those reported for natural teeth¹⁹⁻²² and that the threshold for generation of action potentials from implant loading is higher than for the adjacent natural tooth. Weiner et al²² reported that inferior alveolar nerve responses to implant loading were significantly higher than those of the adjacent teeth. These findings may explain the bite force elevation in implant patients. The combination of implant therapy, reduced PDL sensitivity, and increased VDO in implant patients may amplify the mechanical complications that have been reported in the dental literature and were especially observed in group C in the present study.

Bone loss of 2 mm on the buccal aspect of the implants in group C can be equated to cervical lesions (not caused by caries) found in patients with clenching or grinding habits.³² It is important to note, however, that adverse events associated with implant-supported restorations in this study were limited to porcelain fractures and transitory para-functional behaviors during adjustment to the new VDO. There were no other commonly reported mechanical complications, such as screw loosening or component fractures. This may be attributable, in part, to the implant system's internal implant-abutment connection, which has been documented to eliminate abutment rotation and tilting by creating a "virtual cold weld" between the implant hexagon and the abutment.^{33,34} Once the implant and abutment are attached, a special tool is required to separate the fully engaged abutment from the implant. Compared to the conventional external hexagonal connection, the internal interface connection offers reduced vertical platform height for restorative components; distributes lateral loading deep within the implant; shields the abutment screw from excessive loading; creates a stiff, unified body that resists joint opening; establishes wall engagement with the implant, which buffers the effects of vibration on the abutment screw; offers the potential for a microbial seal; and provides extensive flexibility and the option of lowering the restorative interface to the implant level for improved esthetics.^{33,34}

CONCLUSION

Within the limitations of this study, alteration of VDO was an acceptable procedure in patients with implant-supported fixed restorations, but precautions should be taken to prevent mechanical problems.

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