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# INCREASING VERTICAL DIMENSION: CONSIDERATIONS AND STEPS IN RECONSTRUCTION OF THE SEVERELY WORN DENTITION

Steven T. Cutbirth, DDS\*



*Clinicians often encounter dental patients who have lost tooth structure or demonstrate an insufficient vertical dimension of occlusion (VDO). While reconstructing the proper VDO for such patients can be challenging, the use of a systematic approach can facilitate a successful and predictable treatment outcome. Presented herein are a series of considerations involved in managing and/or restoring the VDO and a reproducible clinical protocol aimed at improving the dentist's ability to increase the VDO while reconstructing severely worn dentition.*

#### Learning Objectives:

This article presents treatment planning and restorative considerations for the treatment of insufficient vertical dimension of occlusion (VDO). Upon completion of this article, the reader should:

- Recognize factors that influence the restoration of insufficient VDO.
- Understand a simple and reproducible chairside approach for predictably increasing VDO.

*Key Words: occlusion, increase, vertical dimension of occlusion, VDO, articulator, aesthetic, night guard*

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\*Private practice, Waco, TX, and Director, Center for Aesthetic and Restorative Dentistry (CARD), Dallas, TX.

Steven T. Cutbirth, DDS, 1613 Lake Success, Waco, TX 76710

Tel: 254-772-5420 • E-mail: [stcutbirth@aol.com](mailto:stcutbirth@aol.com) • [www.centerforard.com](http://www.centerforard.com)

It is sometimes necessary to increase the vertical dimension of occlusion (VDO) when teeth are severely worn and dental restoration is desired. If the occlusal and/or incisal planes are uneven due to dental super-eruption caused by missing teeth, increasing vertical dimension allows these planes to be optimally reestablished.<sup>1</sup> If occlusal/incisal/palatal restorative tooth preparation would eliminate much of the remaining tooth height or result in endodontic treatment, an increase in the vertical dimension should be considered.

The three principal challenges involved in restoring the severely worn dentition are 1) attaining sufficient vertical space for the pending restorations, 2) ensuring enough tooth structure to facilitate retention of the restorations, and 3) preventing the patient from damaging the definitive restorations as they destroyed their natural teeth.<sup>1</sup> This article presents a step-by-step system for restoring severely worn dentition (ie, with lost vertical dimension) that necessitates increasing the patient's VDO.

### Background and Context

Years ago, it was believed by some dental researchers, including the author, that, except in cases of rapid tooth abrasion (eg, when porcelain restorations oppose natural teeth), the VDO is not lost as teeth wear. These clinicians feel the alveolar crest erupts at the same rate at which the occlusal/incisal/palatal surfaces of the teeth are abraded, resulting in no net loss of dental vertical dimension.<sup>2</sup>

That theory may be true in cases of slow dental abrasion but, in the author's experience, it is common clinically to observe cases of vertical dimension loss in severely worn dentitions, even in instances where natural teeth oppose natural teeth. When restoring patients with excessive vertical dimension loss, it is important 1) to obtain additional vertical space and retention for the pending restorations and 2) to restore appropriate facial height to the patient.

Vertical space for dental restorations may be attained by occlusal/palatal/incisal tooth reduction or by an increase in the VDO.<sup>2</sup> Additional retention for dental restorations may be attained externally through periodontal crown lengthening or internally via endodontic therapy, with cast posts extending into the endodontic canals and connected to the definitive restorations.<sup>2</sup>

When one is restoring severely worn dentition with vertical dimension loss, increasing vertical dimension preserves tooth structure by limiting occlusal/incisal/palatal tooth preparation and often eliminates the need for endodontic treatment to gain internal retention or correct uneven incisal/occlusal planes. When the occlusal and incisal planes have become uneven, increasing the VDO (ie, opening the bite) simplifies the correction of those planes.<sup>3</sup>

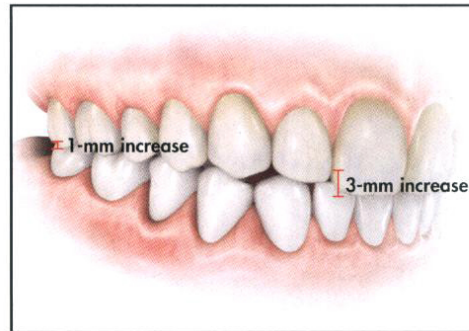


Figure 1. Diagram demonstrates how increasing the VDO posteriorly has a related anterior increase in a 1:3 ratio.



Figure 2. Profile view demonstrates lost VDO, evident in the proximity of the patient's chin to his nose.



Figure 3. Preoperative clinical view of the maxillary and mandibular dentition reveals their worn, yellow appearance.



Figure 4. No central incisor edge display was visible when the patient's lips were in repose.



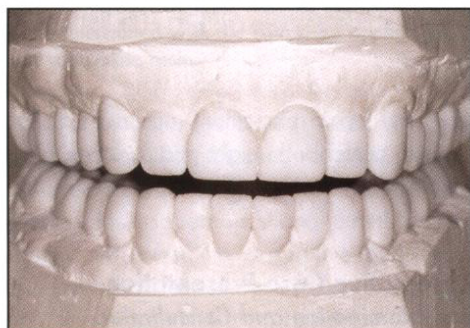
**Figure 5.** Severe wear and pitting of the occlusal and incisal tooth surfaces were noted during clinical examination.



**Figure 6.** The patient's occlusal wear patterns were determined, and large facial exostoses were observed.



**Figure 7.** A cotton-tipped applicator, with a diameter of 3 mm, may be a useful guide for increasing the VDO.



**Figure 8.** Waxed-up study model of the patient following mounting upon a semi-adjustable articulator at the increased VDO.

In severe wear cases of vertical dimension loss, how much of an increase in the vertical dimension is necessary to facilitate predictable restoration? Assuming the patient has a full complement of teeth (ie, all teeth present through second molars) and reasonably symmetrical incisal and occlusal planes, 1.5 mm to 2 mm of additional vertical space is often desired between the second molar (or most posterior) teeth. There is a 3:1 vertical dimension increase ratio between second molars and central incisors, ie, increasing the VDO of the second molars 1 mm opens the vertical dimension approximately 3 mm between the central incisors (Figure 1).<sup>4</sup> Opening the vertical dimension more than 1.5 mm to 2 mm between the second molars generally creates too much additional space between the incisors. Excessive space between the incisors is difficult to address aesthetically, comfortably, and functionally with dental restorations. If the space between the incisors is greater than 5 mm after an increase in the vertical dimension, unsupported porcelain or bulky restorations may result.<sup>5</sup>

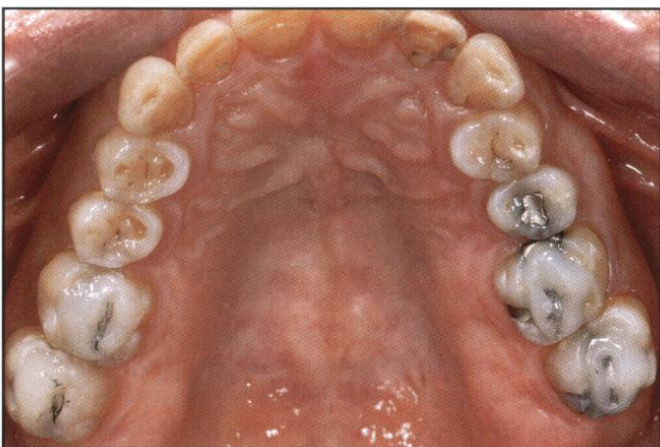
Proper occlusion is critical for long-term restorative success in such cases. Clinical parameters such as centric relation occlusion (CRO); cusp tips on flat opposing surfaces; and no molar or incisor teeth contacting prior to the canine/premolar teeth in CRO are paramount. Also important are the patient's freedom in centric movement (including horizontal occlusal freedom between the anterior teeth in the upright alert feeding position); immediate posterior tooth disclusion in all eccentric movements; and smooth eccentric movements on the canines, premolars, and incisors. Other requisites such as a harmonious envelope of function and an acrylic, flat-plane CRO night guard provide the patient the best chance of long-lasting, comfortable, and functional restorations.<sup>6</sup>

### Considerations Prior to Increasing Vertical Dimension

- 1) Is there sufficient vertical space to restore the teeth? Approximately 1.5 mm to 2 mm of occlusal/incisal/palatal space is required for dental restorations. If the occlusal surfaces are reduced accordingly, will there be enough tooth structure remaining to retain the restorations? Will endodontic therapy be necessary to enable tooth reduction for the restorations? Will internal retention of full-coverage crowns/retainers with endodontic posts be necessary due to inadequate coronal tooth structure remaining?
- 2) Has the patient lost vertical dimension? Are the lips thin? Are the corners of the mouth down-turned when the patient closes his or her teeth? Does the chin protrude and appear too close to the nose (Figure 2) when the patient closes? Is there chafing/redness

(angular cheilitis) at the corners of the mouth? Are the teeth severely worn? Are there significant horizontal wrinkles in the patient's cheek and chin areas? Is there maxillary incisal tooth display when the lips and teeth are slightly parted? Is there too much freeway space when the lips are slightly touching, such that the patient feels the mandible must be closed excessively from the "lips lightly touching, teeth apart" position to maximum intercuspation?

- 3) When vertical dimension is increased, all the teeth in at least one arch must be restored. It is usually necessary to restore all the teeth in both arches to create proper incisal/occlusal planes and to reduce vertical overjet of the anterior teeth.<sup>7</sup> Reducing vertical overjet decreases the shearing load on anterior restorations. When increasing VDO, full-coverage crowns or onlays must be placed on all maxillary teeth and mandibular posterior teeth. Porcelain veneers or full crowns may be used to restore the mandibular anterior teeth.<sup>8</sup>
- 4) The vertical dimension should be increased on the hinged arc of centric relation.<sup>9</sup>
- 5) When vertical dimension is increased, the principles of occlusion apply to the restored case.
- 6) When the lips are slightly touching, the restored teeth should not contact. There should be adequate freeway space such that when the lips are in repose and touching lightly, the maxillary and mandibular teeth should be separated 2 mm to 3 mm.<sup>10</sup>
- 7) Is it the patient's desire and need to undergo full-mouth reconstruction? What are the temperament, circumstances, and dental objectives of the patient? If the patient is basically content with his or her current condition, it may be more appropriate to perform selective composite bonding, endodontic



**Figure 9.** The cured composite resin preserves the desired increase in VDO throughout the restorative sequence.



**Figure 10.** View of the increased VDO (approximately 3 mm) anteriorly following curing of the posterior composite resin.



**Figure 11.** Preparation of the maxillary anterior dentition. The incisal plane of the maxillary anterior restorations should ideally parallel the lower lip line.



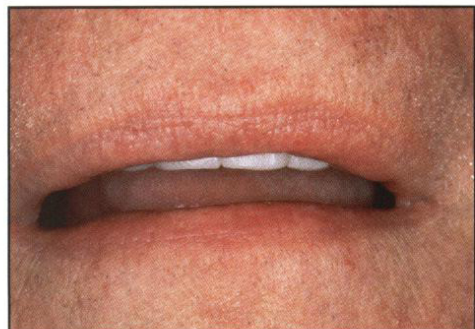
**Figure 12.** Provisionalization of the maxillary anterior dentition.

therapy, crown placement, occlusal equilibration, and to prescribe a night guard rather than a full-mouth reconstruction with an increased VDO.

### Representative Case Presentation

#### **Patient Examination and Consultation**

A 60-year-old male dentist presented for dental examination. The patient's chief complaints were that his teeth were worn and yellow (Figure 3), that there was no



**Figure 13.** Incisal edge display shown in the provisional restorations with the patient's lips in repose.



**Figure 14.** Once the maxillary anterior teeth have been prepared and provisionalized, the same processes are conducted for the mandibular anterior dentition.



**Figure 15.** View of the provisionalized maxillary and mandibular anterior teeth at the desired VDO determined with the cotton-tip applicator and composite resin.

central incisor incisal edge display when his lips were in repose, and that his face looked vertically compressed when he closed his teeth together (Figure 4). This gave him an edentulous appearance and turned the corners of his lips down when he closed his teeth together. Clinical examination revealed the patient had wear and pitting of the occlusal/incisal surfaces of all the teeth as well as significant maxillary and mandibular exostoses (Figures 5 and 6). The patient's occlusal wear patterns were determined. The patient's periodontal condition

was healthy; he had no temporomandibular joint (TMJ) sounds or discomfort, and no myofascial pain or stiffness. The TMJs could be forcefully loaded bimanually without discomfort. The patient's maximum incisal edge to incisal edge opening was 52 mm, with no mandibular deviation upon opening or closing.

It was determined at the postexamination consultation that all the teeth would be restored with an increased vertical dimension. The patient's restorative objectives were to 1) increase his VDO, 2) lengthen the anterior teeth to produce anterior tooth display when his lips were parted and in repose, 3) restore the worn occlusal/incisal surfaces, and 4) lighten the shade of the teeth.

### **Restorative Sequence**

- 1) The desired increase in VDO is first determined. The diameter of the wooden stick of a cotton-tipped applicator (approximately 3 mm), placed between the maxillary and mandibular incisor teeth, is often an appropriate increase in vertical dimension (Figure 7). This produces approximately 1 mm of additional vertical space between the second molar teeth. The amount by which the vertical dimension is increased is not a precise amount, but an approximation based on the minimum amount of additional space needed to restore the teeth appropriately. It is important not to increase the vertical dimension of the posterior teeth too much or there will be excessive anterior space as previously explained.
- 2) Once the desired amount of vertical dimension increase has been determined, an occlusal registration record is taken at the opened vertical dimension. This record can be taken by either placing softened green stick compound between



**Figure 16.** The eight anterior restorations are conventionally cemented from second premolar to second premolar.

the incisors and having the patient close into the compound at the desired opened vertical dimension, then hardening the compound with air from an air syringe, or by placing the wooden stick of a cotton-tipped applicator between the incisors as highlighted above. Fast-set polyvinylsiloxane or occlusal registration record material is then flowed between the posterior teeth to record the increased vertical dimension, in centric relation, for mounting the patient's study models for waxup. A facebow record is also taken.

- 3) Accurate study models of the case are mounted on a semi-adjustable articulator with the facebow and the occlusal registration record taken at the increased vertical dimension. The models are waxed up at the increased vertical dimension (Figure 8). In the waxup, the maxillary centrals should be long enough for incisal tooth display with the lips and teeth slightly parted if the patient's maxillary lip line, in repose, is flat, not arched. If the upper reposed lip is arched, then the lip cannot be used as a guide point in determining maxillary incisal length. The average maxillary central incisor is 10.2 mm in length. The average length of the mandibular central incisor is 8.5 mm. The incisal edge of maxillary centrals should be longer incisally than the other teeth in the incisal plane, with the incisal plane parallel to the lower lip and blending smoothly, without a "step," into the occlusal plane. The mandibular incisal plane should be either flat or slightly arched incisally.<sup>11</sup> Once the incisal planes have been waxed with these points in mind, the posterior teeth should be waxed to symmetrically fill the occlusal space attained from increasing the VDO. Again, the incisal planes of the maxillary



**Figure 17.** The provisional restorations are removed from the maxillary anterior dentition to permit adjustment of the preparations, final impressions, and related diagnostics.



**Figure 18.** The full-coverage crown restorations are tried in, seated, and cemented on teeth #4(15) through #13(25).



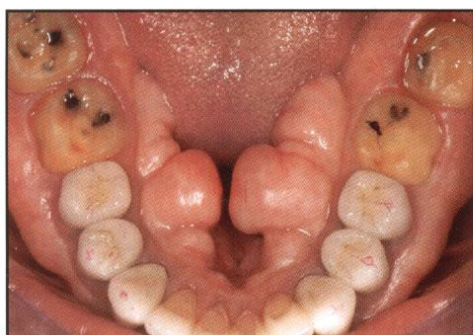
**Figure 19.** Note the aesthetics and increased VDO evident following cementation of the maxillary and mandibular anterior restorations.

and mandibular arches should blend evenly, as perfect "horseshoes" without "steps," into the occlusal planes.

- 4) Preoperatively, if the incisal edges of the maxillary central incisors are not displayed with the lips and teeth slightly parted (ie, lips in repose), the most precise way to establish the ideal maxillary incisal plane in the waxup is to place composite resin on the incisal edges of the maxillary centrals, without acid etching or unfilled resin, as a mockup of the ideal incisal edge position, then take study model impressions of the in vivo mockup for the waxup.
- 5) Restorative appointment #1: The normal order of full-mouth dental restoration when vertical dimension is increased is a) mandibular premolars and anterior teeth, b) maxillary premolars and anterior teeth, c) mandibular molar teeth, then d) maxillary molar teeth. The maxillary and mandibular molar teeth may be restored together in the final stage. Composite resin is first placed on the occlusal surfaces of the maxillary first and second molar teeth. The patient's mandible is bilaterally manipulated into centric relation as the patient is lightly closed onto the cotton-tipped applicator placed between



**Figure 20.** View of anterior restorations in place and completed tooth preparation performed on the maxillary molar teeth.



**Figure 21.** View of anterior crowns in place and completed tooth preparation on the mandibular molar teeth.

the central incisors (Figure 7). The mandibular molar teeth will close into the soft, unset composite until the incisors lightly contact the wooden stick. Microfilm is wiped on the occlusal surfaces of the mandibular molars as a separator. The composite resin is then cured at the open vertical dimension. These composite occlusal stops on the maxillary molars now represent and hold the increased vertical dimension of the restored case (Figures 9 and 10). The maxillary teeth, from second premolar to second premolar, are prepared and provisionalized using a matrix fabricated from the waxed up models (Figures 11 through 13). The incisal plane of the maxillary central incisors should parallel the pupillary line and the lower lip line, and it should be perpendicular to an imaginary vertical line drawn down the center of the patient's face and nose. An incisal edge display of 1 mm to 2 mm is generally aesthetic and comfortable for the patient when his lips are in repose and slightly parted. This 1-mm to 2-mm incisal edge display assumes the patient's upper lip is flat in repose. If it is arched, then there will be additional tooth display when the lips and teeth are parted and in repose. When the incisal edge

is significantly changed, the enunciation of the "f, s, v, church, and swish" sounds must be relearned by the patient, who must read aloud in front of a mirror 30 minutes daily for a few days. The maxillary provisional restorations will not contact the opposing teeth at this time. The mandibular teeth are subsequently prepared and provisionalized from second premolar to second premolar (Figure 14). The mandibular and maxillary provisional restorations will now be in occlusion at the new VDO (Figure 15). Final impressions of the mandibular prepared teeth may be made at this appointment, along with CRO occlusal registration records and a facebow recording. These records are taken against the maxillary provisional restorations. The mandibular premolar and anterior restorations will be built against an opposing stone model of the provisionalized maxillary premolar and anterior teeth. The composite stops on the maxillary molar teeth will continue to maintain the working vertical dimension.

- 6) Restorative appointment #2: The mandibular second premolar to second premolar definitive restorations are seated (Figure 16). The maxillary second premolar to second premolar provisional restorations are removed, and their preparations are refined as needed (Figure 17). Final impressions are made of the maxillary anterior and premolar teeth, along with occlusal registration records, facebow records, and an impression of the mandibular arch with the seated anterior/premolar restorations.
- 7) Restorative appointment #3: Definitive restorations are seated and cemented from maxillary second premolar to second premolar (Figures 18 and 19).
- 8) Restorative appointment #4: The maxillary and mandibular molar teeth are prepared and

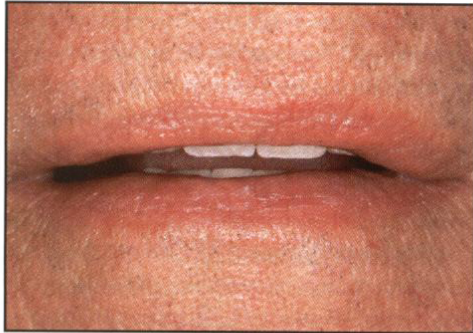


**Figure 22.** Full-coverage crowns with a gold occlusal surface were placed on the molar teeth to diminish the potential of future porcelain fracture.





**Figure 23. Occlusal view of the definitive full-coverage crowns seated on the mandibular molar teeth.**



**Figure 24. Postoperative view of the patient's lips in repose.**



**Figure 25. View of the patient following successful restoration of proper VDO.**

provisionalized (Figures 20 and 21). At this appointment, impressions and occlusal registration records will also be obtained.

- 9) Restorative appointment #5: The maxillary and mandibular molar restorations are tried in, refined, and cemented in place (Figures 22 and 23). The CRO is refined, and a hard acrylic, flat-plane CRO night guard is placed (usually on the maxillary arch). Written oral hygiene and eating instructions are provided, and the patient is dismissed with the restorative objectives achieved (Figures 24 and 25).

## Conclusion

Restoring the severely worn dentition is complicated and technique-sensitive. A thorough understanding of function, aesthetics, and dental materials is necessary to predictably restore these cases. As tremendous stress will be placed on the restored teeth, achieving proper occlusion is critical. This, along with the prescription of a night guard postoperatively, will minimize stress on the definitive restorations and teeth. The patient must be cautioned against eating hard foods and especially against biting hard foods with the anterior teeth.

The patient must be emotionally prepared for his or her part in preserving the restorations and teeth. The patient and practitioner must also discuss responsibility for the inevitable porcelain fracture and/or fractured tooth. Due to the considerable stress on the system, the challenge is not just the initial restoration, but maintaining these restored cases for many years.

*NOTE: Visit [www.ppad.com/exclusives/200810PPAD\\_Cutbirth.pdf](http://www.ppad.com/exclusives/200810PPAD_Cutbirth.pdf) for exclusive web-only images demonstrating this VDO technique.*

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