

Spear *Perspective*

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The art and science of exceptional
esthetic and restorative dentistry

Occlusion in the New Millennium: *The Controversy Continues*

Part 2 by Frank Spear, DDS, MSD

In the previous installment of the Perspective, I addressed three of the five major areas of occlusion. Which teeth should touch in centric, which teeth should contact in eccentric movements, and some concepts about the envelope of function. This leaves vertical dimension and condylar position as the two remaining areas to discuss.

In this issue we'll address vertical dimension. As an educator for over 20 years, few areas seem as misunderstood as the vertical dimension of occlusion. It is common to hear a wide variety of opinions as to where the vertical dimension should be, and how to determine this position. In this issue I'll attempt to answer both questions.

As a starting point, it seems reasonable to address what has established a patient's current vertical dimension of occlusion. Namely the teeth attempting to erupt, and this eruption being held in check by the repeated contraction of the elevator muscles bringing the teeth into contact. It is this concept of an established equilibrium between the eruptive force of teeth and the elevator contraction that leads to one of the theories concerning vertical dimension, that it can't be altered. There is however another group who claims that any alteration will be followed by a subsequent adaptation of the muscles, so that altering vertical is not a concern. As with all theories, until they are scientifically tested, they make for spirited discussions with no resolution. So our discussion of altering vertical dimension will also need to include the findings of a literature review on vertical dimension.



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To begin this review, I would like to focus on the areas dentists most often tell me concern them about altering vertical dimension. TMJ pain, muscle pain, stability, bite force, and phonetics.

TMJ or muscle pain: A literature review is quite clear regarding the alteration of vertical dimension and pain. The two are virtually unrelated. That is, as long as the patient has joints that are pain free, altering the vertical dimension does not create pain. At most 5% of patients may notice some transient muscle awareness that is gone within 7 to 14 days. So the practitioner who desires to alter vertical dimension and can do so without the introduction of joint pain or muscle pain being a side effect. It is also important to realize this means that there is no single vertical dimension that produces comfort. So any philosophy of occlusion that treats to a specific vertical dimension to produce comfort is not supported by the literature.

Stability: The previously discussed equilibrium theory of vertical dimension would clearly state that any alterations to vertical dimension would be followed by a return to the pre-existing vertical

dimension of occlusion. A study of the literature concerning the alteration of vertical dimension would show that this is in fact true, some of the time. That is, there are numerous studies both human and animal that show following a change in VDO (vertical dimension of occlusion) a tendency to return towards the original VDO. If the vertical was increased there can be a subsequent intrusion of the teeth with the vertical closing back down, and with a decrease in VDO their can be a subsequent eruption of the teeth with the vertical reopening. The challenge is that these instabilities don't occur in every case. They don't return always to their original position and sometimes the smallest vertical changes result in the greatest relapse. The challenge then

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becomes how does this apparent instability effect our clinical decisions. The common reasons for altering the vertical dimension of occlusion are for esthetics, occlusion, or to gain space to structurally restore worn teeth. The real question we should ask, is if the vertical does return towards its original position, do you lose the benefit of the vertical alteration? To answer this, it's important to understand how the teeth erupt or intrude. It is not like a nail in a piece of wood, where eruption would be like pulling the head of the nail out of the wood, and intrusion would be like driving the nail into the piece of wood. Instead eruption and intrusion occur by the wood changing, leaving the relationship of the head of the nail to the wood unchanged. In the case of teeth it's the alveolus that changes leaving the CEJ to create bone relationship unchanged. In addition this change via eruption or intrusion is shared via both arches. That is, any dental changes will result in the teeth in each arch experiencing half the change. What this means clinically is significant in that the reason for performing the original alteration in vertical dimension will probably maintain in spite of the alveolus remodeling. As an example, suppose you chose to open the vertical anterior 2 to 3mm to gain space to restore a patient with severe wear. But following the restoration, the vertical closed down 1mm. Since you had restored all the teeth into contact to change the vertical, you still have the desired room needed for the restoration even though in fact the vertical has closed some. What's more, is that since vertical changes don't produce pain, this change took place silently without you or the patient even being aware it was occurring. At most it might have required some additional occlusal adjustment. I believe it is this silent changing that makes many practitioners assume their vertical dimension changes are stable. They open the bite, the patient is comfortable, the occlusion is stable, and they presume the vertical relationship between the maxilla and mandible is stable. When in fact there probably is some alteration that does occur if they had placed markers in the basal bone of the maxilla and mandible and tracked the change. The other area that is clear from the literature about

stability is that any changes that will occur following an alteration in vertical dimension occur in the first six months following the change. And following that, the VDO is very stable.

The last area regarding stability that may result in some confusion as to why some patients relapse and others don't, is where most studies measure the vertical change in the anterior maxilla and mandible. This can provide erroneous findings with regard to vertical relapse for several reasons, but most significant is the geometric relationship of the TMJ's, elevator muscles, and anterior teeth. We know that for each 3mm of anterior opening there is approximately a 1mm opening in the molar region. But, for each 1mm of condylar seating, there is approximately a 1mm vertical closure in the molar area. Since the insertion of the masseter and medial pterygoid correspond to the location of the molars, any anterior vertical change will effect the length of the masseter and medial pterygoid at approximately a 1 to 3 ratio. Meaning opening the anterior 3mm lengthens the muscles roughly 1mm. If at the same time, however, the condyle was seated 1 mm during treatment, that would tend to shorten the masseter and medial pterygoid, leaving the muscles similar length to their original VDO, even though the anterior vertical was increased 3mm. Since condylar position was not factored in the literature studies, it may be one reason some patient's anterior verticals did not change. Those whose condyles were seated significantly during treatment. While some of the patients whose verticals did relapse may not have had much condylar shift during treatment.

So what's the bottom line on stability? We know in some patients VDO will relapse after its altered, but it won't produce pain, you still gain the benefits of why you altered the vertical, and the change will be stable in 6 months. So if you are concerned about future instability, placing the patient in temporaries for 6 months prior to finishing eliminates the issue.

Bite force: Unlike stability, which is very involved and not always consistent as to how it changes, bite force is easier to evaluate. Muscle research has shown that maximum bite force is achieved

when the sarcomeres in the masseter muscle are lengthened 2.5 to 3mm. This translates into 6 to 9mm of incisor opening for most patients. Increasing vertical does increase bite force. This can be seen in studies, which measure bit force and muscle activity electromyographically. Interestingly however, this increase in electromyographic activity at the more open vertical is not maintained long term. That is evaluating muscle activity 3 months post treatment often shows a maximum clenching activity similar to the pretreatment level. Whether this occurs because some vertical relapse occurs during those 3 months or because of some neuromuscular change is unclear. What is clear is that clinically, long term, the increased bite force does not appear to be an issue.

Phonetics: Specifically the sibilar "S" sounds. We all remember checking the closest speaking space on our first dentures and how when the patient said Mississippi we wanted to see 1 mm of clearance between the maxillary and mandibular anterior teeth. If the patient's teeth contacted during the "S" sound, the tongue would not be able to control airflow and the patient would lisp. Repositioning the teeth to correct the space eliminate the lisp and in dentures, if the closest speaking space was not corrected, the lisp would remain and the patient would tend to click their teeth together. For patients with teeth, the closest speaking space is also an issue. The difference is that because of the proprioception of teeth, there is more potential to adapt to and alter the closest speaking space through neuromuscular reprogramming rather than making a dental change. So how does this relate to DO? It does specifically if the position the patient places their mandible in to say "S" is the same position they occlude in. For example many patients posture their mandible forward and make their "S" sound end to end. Let's suppose they have a lisp following the placement of some full coverage temporaries on their maxillary arch. To correct the lisp you have to either shorten the maxillary incisors or mandibular incisors. Since the maxillary teeth were done for esthetics, we will presume you will shorten the mandibular incisors until a

closest speaking space is recreated and the lisp is gone. How, however, when the patient returns to centric closure they have no anterior contact because the lower incisors were shortened. This is not a problem because by simply adding to the lingual of the maxillary anteriors the contact can be regained at the same vertical without re-affecting speech.

If however the patient occludes and speaks in the same mandibular position, and they have a lisp because you opened the bite, and lengthened the teeth by placing a full arch maxillary temporary, you have a new problem. Now you can shorten the mandibular incisors again to correct speech, but you can't regain centric contact by adding to the maxillary anteriors because the speech problem will return. Hence, if the patient has a phonetic problem, but they say their "S" sounds in the same mandibular position as they occlude, you will first have to alter the anteriors to correct the phonetics. Then close the vertical back down to regain centric contact. This is not uncommon in Class II or Class III occlusions where the patient often says their "S" sounds in the same mandibular position as they occlude.

The previous discussion has focused on the literature concerning the five most common areas of concern when altering vertical dimension. Let us now turn our attention to the determination of vertical dimension.

Freeway space: The first discussion every dental student has concerning vertical dimension is regarding freeway space. Specifically, the distance between the position of the mandible at rest, and the position of the mandible when the teeth are in maximum intercuspation. Depending upon your school, you were probably told that freeway space should be 2 to 4mm, and that if you wanted to open someone's vertical dimension, you would need a freeway space greater than 4mm to start with. And if you infringed on freeway space, the patient's vertical would be over opened and they would click their dentures when speaking and chewing

which we all know is true. The question is, do the same rules apply to patients with teeth? The literature is very clear that the answer is no. Multiple studies have intentionally infringed on dentulous patients' freeway space with appliances or restorations only to discover that within 2 to 4 weeks the freeway space has returned to normal. This probably occurs for several reasons, but most likely relates to a neuromuscular reprogramming of rest position. In truth, the position we use to determine freeway space is not rest position, but more correctly termed, according to Sandro Palla, habitual mandibular position. The position we hold our mandible when our head is upright. It is in fact a position of some muscle activity. True muscular rest is where our mandible is when we fall asleep with our head upright and our jaw dropped open. It is in that position that the elevator muscles are relaxed.

The habitual mandibular position we attempt to

“The one thing that virtually all occlusal philosophies agree with today is even, simultaneous tooth contacts on all posterior teeth and canines in centric closure.”

identify by asking the patient to say “MMMMMMM” is then a position that the patient has habituated too. And it appears to be under complex neuromuscular control. For example, while jogging you can maintain your mandible in the same position yet increase the tone of the muscles to prevent your jaw from bouncing. It appears that in dentulous patients the proprioceptive system feeds back to the CNS control centers to alter habitual mandibular position to regain freeway space following alterations in vertical dimension. Making freeway space a poor determinant of vertical dimension in the dentulous patient.

Trial splint: The literature is replete with articles on how to test vertical dimension changes by fabricating a trial splint for the patient to wear. The concept is simple, place the splint, the patient wears it. If they are comfortable the inference is that the vertical dimension is acceptable. If they are not, the vertical is unacceptable. The problem of using a trial splint is simple. Since the literature is clear that altering vertical does not produce pain, the trial splint is a poor test or determinant of vertical dimension. In fact the most common treatment provided by dentists for patients in pain is an appliance which opens vertical dimension.

Neuromuscular: The use of a TENS (transcutaneous electrical neural stimulation) device to determine vertical dimension has been proposed for several decades. In this approach, the TENS unit is attached and the muscles pulsed to fatigue and relax them. This is verified by the patient wearing EMG electrodes over their anterior and posterior temporalis, masseters, and digastrics. The operator can then view the degree of muscle activity on the computer. And at the point of lowest elevator muscle activity without increased digastric contraction, the vertical is noted. This is easily accomplished if the patient is wearing a jaw tracking device so that the changes in mandibular position can be visualized on a computer screen. Once this point of low elevator muscle activity (neuromuscular rest position) is found. It is marked on the computer screen.

The operator then chooses the freeway space they desire, typically 1-2mm and this becomes the new VDO. The literature would say that this new VDO using the neuromuscular approach is typically 1 to 3mm open compared to maximum intercuspation. The weaknesses in this approach are the same as using the conventional approach to freeway space. The only difference is that instead of determining the starting point, by having the patient say “MMMMM” it is done electronically. But the problems of the patient's neuromuscular feedback system still exist. So in one study of nearly 1200 patients, after 3 months at the new vertical, reassessment using the same electronics showed over 70% of the patients would need to be reopened to achieve the desired goals.

CEJ's of anterior teeth: Another common method described to determine vertical dimension is to measure from the CEJ's or free gingival margin of the maxillary to mandibular incisors. Then compare this measurement to an average of 18 to 20mm. If the patient's gingival margins were than 14mm apart, the decision would be made to open the vertical 4mm to equal the average. The problem of this method is quite simple. The anterior teeth do not control the maintenance of VDO, the posterior teeth do. Measuring from the CEJ's or gingival margins of the maxillary and mandibular incisors simply evaluates the state of anterior tooth eruption, not the VDO. For example, a patient may have severe anterior wear as in bulimic and no posterior. As the anteriors wear then erupt to maintain contact. Now measuring the CEJ's of the anteriors looks as though the patient has lost vertical, but they haven't at all. They have simply had wear and secondary anterior eruption. And the most likely treatment needed is not to open the bite, but to orthodontically intrude the anterior teeth then restore them, or crown lengthen the anterior teeth then restore them. As a simple rule, if the posterior teeth are present, in occlusion, and unworn, the patient has not lost vertical dimension regardless of how the anterior teeth look. And most can also be treated at their current vertical dimension if they are willing to reposition the anteriors orthodontically or through perio surgery and restoration.

Facial Esthetics: Another method designed to determine vertical dimension is to use facial proportion. In an ideal face the midface measured from glabella (between the eyebrows) to the base of the nose, should equal the lower face measured from base of nose to chin. The use of this method then is quite simple. Make the measurements and adjust VDO to alter the lower face to match the midface. There are multiple weaknesses to this approach for the restorative dentist. For example, what if we have a patient whose lower face is 5mm longer than their midface. Can the restorative dentist close the vertical 5mm. Or a patient who has an ideal occlusion, but a small chin so that the vertical would need to be opened 5mm. Can the restorative dentist correct the facial proportion that much and maintain pleasing tooth size and occlusal relationships? The answer is

no. It is not that pleasing facial proportion is not a goal, but altering it with restorative dentistry is rarely the correct option. In addition a recent paper increased vertical on a group of patients using removable appliances 2, 4, 6 and 8mm. Then had a group of dentists evaluate the facial appearance to see if they could tell the difference. The dentists could not distinguish between the dentists own VDO and increases of 2, 4 or 6mm. Why? Because when we look at each other the proportion we see is the patient with their mandible in habitual position not maximum intercuspation.

Cephalometrics: It is common in orthodontic analysis to use cephalometric analysis to and in the decision process of treatment planning along with facial soft tissue and dental relationships, and treating to cephalometric norms regarding maxilla to mandible is very logical. But it is not a methodology easily applicable to restorative dentistry. The restorative dentist effectively only alters the teeth. The orthodontist repositions the teeth, gingiva, alveolus, and in the case of orthognathic surgery, the basal bone as well. So altering facial proportion and treating to a cephalometric range is logical for orthodontics, as a method of aiding in the determination of vertical dimension.

Contracted muscle length: One method of determining vertical dimension that has been described is to evaluate how much your desired vertical change will alter the length of the masseter and medial pterygoid muscle. This can be done quite simply. We previously discussed the geometry of the condylar position to masseter muscle to anterior tooth relationship. As the vertical is opened anteriorly 3mm the muscle lengthens 1mm. But, for each 1mm the condyle seats posteriorly the muscle shortens 1mm. So for each 1mm the condyle is seated in the new restoration from its position when the teeth are in maximum intercuspation, the vertical dimension of the anteriors can be increased 2 to 3mm with no apparent change in masseter or medial pterygoid length. Determining the amount of condylar seating is quite simple. Mount models using a bite record in a seated condylar position. Then using a device such as an MPI (SAM), CPI (Panadent), or Verichech (Denar) move the models into maximum

intercuspation on the articulator and measure the vertical condylar displacement on the device. The vertical condylar movement can then be used to compute the amount of anterior opening that would require no muscle adaptation. The literature states that an average condylar displacement for most patients would be .7mm to 1mm, meaning most patients could have their anterior vertical increased 2mm with no muscle change if restored in a seated condylar position. The weakness of this technique is simple. It gives you a range in which you could increase the vertical with no muscle change, but doesn't say you can't increase it more or where to put the vertical.

So how do we truly determine the vertical dimension of occlusion? All of the above techniques attempted to find a vertical relationship of the maxilla to the mandible and then the assumption was that the teeth would be created at that vertical. In fact for the restorative dentist, the esthetic, functional, and structural requirements of the teeth will determine the VDO. To not follow this path is illogical. The literature discussed previously on pain, stability, bite force, and phonetics are clear, there is no such thing as a correct vertical dimension. Rather there are a number of vertical dimensions that can be used successfully. Consequently, building to a preset vertical dimension because a philosophy of occlusion proposes it is not supported. Not that the position is unacceptable. But, often the position requires large quantities of dentistry be done to achieve the desired vertical. When in fact on equally successful result could have been achieved at a different vertical with for less dentistry. So what really controls vertical? Anterior teeth. We said earlier posterior teeth control the existing VDO. But when the vertical dimension is being changed, the anterior teeth will determine the new vertical. For example, a patient who is having complete coverage restorations done on all the maxillary posterior teeth, but anterior restorations. What vertical do you use? The ones where the anteriors will contact with the condyles seated. The same is true when doing an equilibration. The posteriors are adjusted until the anteriors are in contact.

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What about when the anteriors and posteriors are being restored. The esthetic, occlusal and space requirements to correct the anterior teeth will set the new vertical. Failure to let the teeth dictate vertical can result in excessively large teeth, inappropriate occlusal relationships, and excess

dentistry being performed unnecessarily to meet some preconceived vertical goal. In conclusion, the evidence on vertical dimension is clear. Whatever you choose, the body will probably adapt to without pain although with some alteration in stability for a period of time. So in the end the vertical

should be dictated by the needs of the patient. Simply put, use the vertical dimension that accomplishes the esthetic, functional and structural goals for the patient while doing the most conservative amount of dentistry possible.

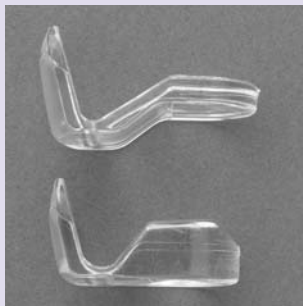
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