Occlusion in the New Millennium:
The Controversy Continues

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The goals when creating a new occlusion are quite simple: control the load applied to the temporomandibular joints (TMJs); control the load applied to the teeth and periodontium; and ensure muscle comfort and function. To achieve these goals, the clinician manipulates how, when, and where the teeth contact each other. The control of applied force is obviously the key. There are only two ways the dentist can affect the applied force. The first is to alter the occlusion so the muscles can accomplish the task of mandibular movement with less force. The second is to redistribute the applied force to more favorable locations, ie, to a greater number of teeth or different teeth.

In controlling tooth contacts, five variables must be evaluated: 1) which teeth will touch in centric closure, 2) which will touch in eccentric movements, 3) the steepness of the anterior overbite and posterior occlusal anatomy, 4) the vertical dimension of occlusion, and 5) the condylar position, which is used to build the occlusion. It is important to evaluate each aspect to determine its impact on the ultimate occlusal goals.

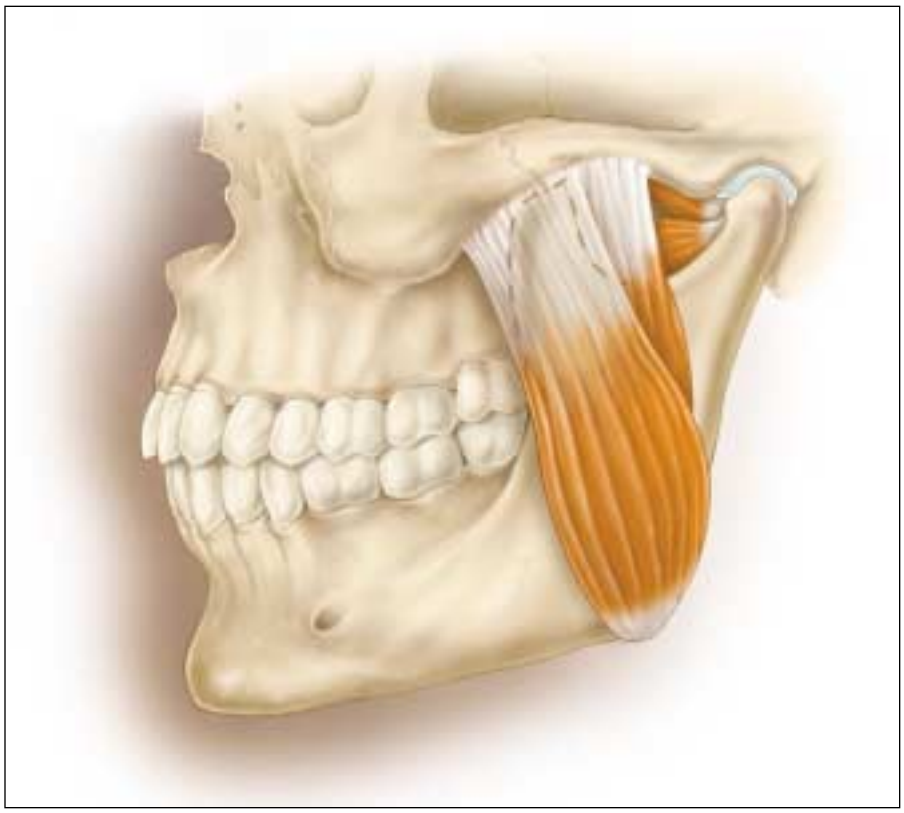
1. Which teeth should touch in centric closure?

The one point agreed upon by virtually all occlusal philosophies is even, simultaneous tooth contacts on all posterior teeth and canines in centric closure. From a load distribution standpoint, this is very logical. If only a few teeth are touching, all the force goes to those teeth. Even contacts on all the posterior teeth redistribute the load so each tooth ultimately bears a reduced portion.

From the perspective of the TMJs, even contact of the posterior teeth also makes sense. The mandible functions as a Class III lever system, where the joint is the fulcrum, the muscle provides the power, and the teeth are the resistance.[1] In a Class III lever, the farther the resistance point is from the fulcrum, the less force is applied to the point of resistance. For example, a second molar that is closest to the muscle and the joint receives, on average, nine times the bite force received by an incisor, the farthest away from the joint and muscle.

When the patient produces tooth-to-tooth contacts, however, the Class III lever can function in reverse. That is, the teeth become the fulcrum, the muscle the source of power, and the joint must offer resistance. It has been shown[2,3] that when only anterior teeth touch, 60% of all the bite force goes to the joint. If the second molars touch, only 5% of the bite force is allowed to reach the joint. The molars and other posterior teeth absorb the remaining force. Equal posterior contact not only redistributes the load on the teeth, but also reduces the load received by the joint.

In none of these occlusal contact scenarios does the actual axis of rotation leave the condylar area. Some authors[4] have suggested that upon closure, when molars contact, the axis of rotation moves to the cervical vertebral area and the condyle is distracted inferiorly, opening the joint space, which then allows the anterior teeth to gain contact. This concept would require that there be an elevator muscle anterior to the molars, which could close the anteriors



The masseters, temporalis, and medial pterygoids are all anatomically posterior to the molars.

together. The masseters, temporalis, and medial pterygoids are all anatomically posterior to the molars (Figure), making it physically impossible to move the condyle simply by building up posterior teeth. This is also why changes in vertical dimension must be performed around the condylar axis of rotation on an articulator. The use of instruments that open the vertical dimension straight up and down will produce an anterior open bite. This occurs because of premature molar contacts, unless the patient brings the anterior teeth together by pushing the condyle inferiorly and forward, but still against the eminence.

2. Which teeth will touch in eccentric contacts?

Most current occlusal philosophies agree that when the mandible moves from maximum intercuspation, the anterior teeth should guide the contact, and the posterior teeth should not touch either on the working side (side the patient is moving towards) or the nonworking side (side the patient is moving away from). This is logical from the point of view of muscles and load distribution. From the muscular perspective, having only anterior tooth contacts has been clearly shown to produce less elevator muscle activity than when a posterior tooth is allowed to touch on the working side (group function) or nonworking side (balancing interference) during lateral movements.[5,6] From a force distribution perspective, anterior guidance is also logical. Since anterior teeth receive less load due to the Class III lever principle, it makes more sense to have them receive lateral loads rather than the posterior teeth, which receive far more force. While there are exceptions to this principle of anterior guidance, they are rare.

3. What overbite and posterior anatomy should a clinician use?

This is the first area in which significant discrepancies arise between occlusal philosophies. Simply put, the major differences are whether the anterior guidance alters the way the mandible moves and functions, or whether the way the mandible moves and functions determines the anterior guidance. Classically, one would utilize gnathology to trace the pathways of condylar movement, and then use those pathways to develop the anatomy of the posterior dentition. The anterior guidance was then created as an analog of condylar guidance and to disclude the posterior teeth. A very precise occlusal scheme is created in which posterior disclusion is achieved by cusps traveling through pathways in the opposing teeth. To create this type of guidance and disclusion requires precise tracking of mandibular movement and its transfer via pantograph to a fully adjustable articulator. The bioesthetics developed by the late Dr. Robert Lee was an evolution of gnathology. After studying the skulls of humans with unworn teeth, Lee proposed a fixed anterior guidance where the maxillary centrals are 12.0 mm in length, the mandibular centrals are 10.0 mm in length, and the vertical dimension is set by placing the cementoenamel junctions of the maxillary and mandibular central incisors 18.0 mm apart. This produces an overbite of 4.0 mm to 5.0 mm; the overjet is set at 2.0 mm for the incisors, and 1.0 mm for the canines. This steep guidance pattern allows the creation of a very steep posterior occlusal anatomy with disclusion. This anatomy is believed to reduce muscle activity during chewing, thereby reducing the force on the anterior teeth. The difficulty with both the pure gnathology and pure bioesthetic approaches appears to be in their attempt to create occlusal schemes based upon purely mechanical formulas, which fail to recognize the neuromuscular variability that exists among patients.

This leads to the Pankey-Dawson concepts of occlusion. In both philosophies, the anterior guidance is developed first around the patient's neuromuscular requirements (ie, tooth wear, fremitus, mobility, phonetics, and patient comfort). Only after the completion of anterior guidance is the posterior anatomy created, which allows for immediate disclusion of the posterior teeth. In general, the posterior anatomy is shallower, with cusp tip to flat plane contacts or shallow tripod or reciprocal contacts, than in gnathology or bioesthetics. This results in the clinician's ability to use a semiadjustable articulator and still get an acceptable occlusion in the mouth, since the posterior teeth are designed to immediately disclude in excursive movements. In the author's opinion, this concept of developing a customized anterior guidance to fit the patient's neuromuscular pattern is critical to the longevity of today's all-ceramic restorations.

4. What vertical dimension of occlusion should one use?

Whether vertical dimension can or cannot be altered from the patient's existing vertical dimension of occlusion is highly controversial. The concerns expressed are usually the following:

- The patient will experience muscle pain.
- The patient will experience joint pain.
- The patient will have speech problems.
- The occlusion will not be stable and will close back down.
- The patient will place greater force on the teeth and fracture restorations.

To clear up the controversy, it is important to realize what created the patient's current vertical dimension of occlusion (VDO). It is generally believed that current VDO is an equilibrium between the repeated contraction of elevator muscles and the eruptive force of teeth. That is, we know teeth will erupt; what prevents that from continually happening is the muscle repeatedly closing the teeth into contact. The question is: "If the teeth are changed, how do the muscles respond?"

To answer this, it is imperative that a more specific description of vertical dimension be given. In fact, there are three vertical dimensions—the anterior teeth, the muscles, and the joints. Due to the mechanics of the mandible, when the anterior vertical dimension is increased 2.0 mm to 3.0 mm, the masseter muscle lengthens only 1.0 mm—less than 50% of the anterior opening. The TMJ, however, also has an impact on muscle length. If the condyle is displaced during maximum intercuspation anteriorly and inferiorly, as is common, then by seating the condyle superiorly in the fossa when restoring the occlusion, the masseter muscle actually shortens in an almost 1:1 relationship to the amount of condylar seating. Since it is the masseter that creates most of the force applied to the teeth and joints, it is in fact possible to increase the anterior vertical dimension while at the same time seating the condyle superiorly. The masseter muscle length will not change if the ratio of condyle seating to anterior opening (1:2) is considered. If the muscle length is unchanged with the new occlusion, all the other variables remain the same.

There will be times, however, when an increase in muscle length is necessary. So how do the joints and muscles respond? First, with regards to muscle pain, research tends to support that increasing muscle length does not produce pain within the muscles, and if it does, the discomfort lasts only 1 to 2 days.[7-11] Next, with regards to joint pain, a normal, healthy TMJ is meant to receive load, as are all the other joints of

the body. If the TMJ is painful upon loading, the complete disk is typically anteriorly displaced, allowing the condyle to press on the retrodiscal tissue that is now between the condyle and the eminence. If the disk is correctly aligned, then pain upon loading is most commonly not occurring within the joint. Rather, it is coming from the inferior belly of the lateral pterygoid muscle as it stretches to hold the condyle down and forward. So, does opening the vertical produce pain in the joint? Not in a healthy joint. In a pain-free joint with complete disc displacement, the key to controlling the load is to create stable posterior tooth contacts at the new vertical dimension. It is the creation of stable posterior contacts—not the vertical dimension—that controls joint loading.

What about occlusal stability and vertical changes? If the vertical dimension increases masseter muscle length, it appears that the stability of the occlusion may be a concern. There is definite evidence to support the view that when masseter muscle length is increased, some patients will intrude their teeth and produce a more closed vertical. This closure appears to occur within 6 months.[12] If posterior teeth are loaded in an axial direction while anterior teeth are loaded in a nonaxial direction, the anterior teeth may become mobile, splaying anteriorly, or developing a deeper overbite as the posterior teeth intrude. Whether this is a problem depends upon the patient's neuromuscular pattern of movement.

What about phonetics and opening a bite? Interestingly, in most patients who have their own teeth, patterns of speech are quickly readapted to the new vertical dimension. This is very different from how denture patients respond. There are times, however, when patients won't tolerate the phonetics of the new vertical dimension, and it will be necessary to close the occlusion back down. This is often the case in Class III malocclusions.

What about bite force on the teeth and restorations, and the new vertical dimension? It has been reported in the literature[13] that there is less muscle activity measured by electromyography at a more open vertical dimension. This use of electromyography almost always results in a more open vertical than the patient's existing VDO. This should come as no surprise; whenever we lower activity in our elevator muscles, our mandible drops to a more open position. The key problem with the entire neuromuscular concept is that it is concerned with finding the amount of electrical activity in the muscles at rest. In every other system we have discussed, the goal is to create the lowest level of muscle activity during function to minimize the load on the teeth. The neuromuscular approach states that when the patient clenches at the new electronically attained vertical dimension, he or she produces greater levels of muscle activity than the old vertical dimension and that this demonstrates the new vertical dimension to be "more functional" than the old, but actually all it demonstrates is that the patient is able to place a greater load on the system than previously.[14-16]

So, is opening vertical dimension effective or ineffective? It depends on the patient. Almost none will experience pain. If the tooth contacts are managed properly, joint loading is not an issue. Some patients may reintrude their teeth if their masseter muscles are excessively lengthened. Many may be able to produce greater bite force although their resting muscle activity levels are lower. In the end, the one significant issue is the amount of dentistry that is necessary to change vertical dimension. Any vertical opening requires the restoration of the anterior and posterior teeth in at least one arch. If these teeth need to be corrected for aesthetic or functional reasons, then opening the vertical makes sense. If they are being restored to achieve an occlusal position created by resting EMG measurements, however, the danger of overtreatment exists.

Consider the hinges of the door as the joints, the door and the door frame as the maxilla and mandible, and the opening and closing of the door as the muscles of mastication.

5. At what condylar position should occlusion be built?

As with vertical dimension, tremendous controversy surrounds condylar position. Perhaps the most lucid explanation is to use the example of opening and closing a door. Consider the hinges of the door as the joints, the door and the door frame as the maxilla and mandible, and the opening and closing of the door as the muscles of mastication. When the hinges, door, and door frame are properly aligned, the door opens and closes with minimal muscle activity. When the door and door frame are out of alignment, tremendous activity must be exerted to open and close the door. The same is true of the teeth. When the joints and teeth are in harmony, the masticatory muscles need apply little effort to close or move the mandible. When they are out of alignment, however, the muscles must be constantly active. If the door and its frame are out of alignment, the carpenter can either reset the hinges or sand down the door. Dentists do not have the ability to reset the joints, so they alter the teeth to be in harmony with the joints.

What condylar position do we choose for harmonious occlusion? When reviewing options, we can use the 1) most superior condylar position within the fossa, 2) the most retruded position that will be inferior and posterior to the most superior one, or 3) an anterior position with the condyle down and forward from the most superior position. For this discussion, we will assume a normal joint with the disk properly positioned and no pain on loading. It is important to understand the criteria used. The first is reproducibility—the most superior position has been shown to be the most consistently reproducible over multiple appointments.[17-22] Second, the desired condylar position should require minimal activity for the elevator muscles and the lateral pterygoid. The only condylar position shown to allow a complete lack of lateral pterygoid activity is the most superior position.[23] Any condylar position anterior to this will require the lateral pterygoid to contract to position the mandible forward. The myocentric position determined by the neuromuscular stimulation of the fifth and seventh cranial nerves will always create an anterior position, because the lateral pterygoid is triggered to contract by electrical stimulation. Accordingly, this creates an occlusal position that requires the pterygoid be active every time the patient closes. Since it is not possible to place a surface electrode on the lateral pterygoid muscle, its increased activity does not show up on the EMG display when monitoring post-treatment muscle activity levels.

Along with reproducibility and decreased muscle activity, the third goal for a condylar position is that it be a border position, one in which it is possible to evaluate the occlusion in any mandibular movement. The only position from which this can be accomplished is the most superior condylar position. Any condylar position that allows the condyle to seat more superiorly will automatically result in posterior interferences. This is true whether the selected position is

down and forward or down and backward. Currently, the most superior position is called centric relation.

There are several myths that go along with the use of centric relation. One is that it is painful. In fact, unless there is an intracapsular joint concern such as anterior disc displacement or retrodiscitis, there is nothing to produce pain in the joint when the condyle is seated superiorly. Any discomfort experienced is almost always muscle related, providing the joint is healthy. The fact that there is muscle discomfort, almost always lateral pterygoid, shows that the pterygoid has been hyperactive, posturing the patient's mandible forward into the existing occlusion. As the condyle attempts to seat superiorly, it stretches this hyperactive pterygoid and produces the discomfort. When the condyle is seated, the muscle can shut off and be completely comfortable.

Another myth is that patients don't go to centric relation. The only things that keep patients from centric relation are interfering tooth contacts and contraction of the lateral pterygoid. When a patient lays his or her head on the pillow at night, if the mouth is open so teeth don't touch and the lateral pterygoids are relaxed, the patient will close in centric relation every time and contact whatever posterior tooth is the interference to the condyle seating.

The final myth is that centric relation is hard to achieve clinically. It is only hard to achieve in patients with joint pathology or hyperactive musculature, or with those clinicians who are not trained. In those patients with hyperactive muscles, the use of a deprogrammer, such as a Lucia jig or cotton roll on the anterior teeth, will separate the posterior teeth, relax the lateral pterygoid, and allow the anatomy of the joint and the elevator muscles to seat the condyle. In some cases, it may be necessary to create a bite appliance to aid in this muscle relaxation.

What happens if the most superior condylar position is not used? The answer depends upon the patient and his or her adaptive response to the posterior interferences present. Some patients will simply play with the interferences, without pain. Others may develop hyperactive muscles and accompanying pain. The worst are patients who brux! When the condyles seat, only the posterior teeth are touching, and bruxers stand a high chance of fracturing or wearing restorations.

Conclusion

For years, clinicians have been trying to find the best way to restore patients—the "perfect" overbite, or tooth length, or vertical dimension. Unfortunately, it seems that such a method often leads to massive overtreatment. In the 1970s, I placed gold onlays on nonrestored teeth to create the tripod contacts required by the gnathologic principles I practiced at the time. How often have teeth been restored to match the length and overbite dictated by the principles of some philosophy when they didn't need any restoration at all? The combination of the principles of orthocranial and neuromuscular occlusion may result in the need to perform full-mouth rehabilitation on half the population. That these patients don't hurt afterward is not surprising, as humans are amazingly adaptable. My concern is that we're trying to treat every patient in the same way, because it's convenient, computerized, and easy to learn. That's a tremendous amount of dentistry being done to accommodate a mechanical belief. Proper examination, diagnosis, and the development of the most conservative plan to achieve the goal always work.

How often have teeth been restored to match the length and overbite dictated by the principles of some philosophy when they didn't need any restoration at all?

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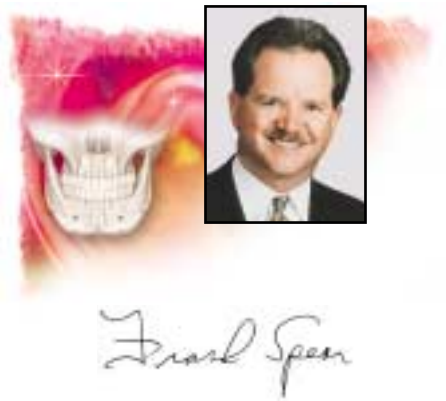

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