SPECIAL ARTICLE

Myths of orthodontic gnathology

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Dr Beverly McCollum established the Gnathologic Society in 1926. Gnathology is defined as "the science that treats the biology of the masticatory mechanism as a whole: that is, the morphology, anatomy, histology, physiology, and the therapeutics of the jaws or masticatory system and the teeth as they relate to the health of the whole body, including applicable diagnostic, therapeutic, and rehabilitation procedures."[1] Many gnathologic research endeavors have added much to our knowledge and understanding of the stomatognathic system, particularly those involving chewing (masticatory) kinematics[2-13] and the early intraoral telemetry studies (to cite only a few).[14-17] Although originally founded on scientific principles, the application of the valid gnathologic research to clinical practice has moved away from these founding tenets. Modern clinical gnathology (vs university-based gnathologic research) has become, for the most part, a pseudo-science based on mechanistic, perfunctory procedures, and instrumentation. There are many contemporary occlusal institutes that clearly have perverse views on gnathology that are not evidence-based. Dr Lysle Johnston[18] sarcastically stated that "gnathology is the science of how articulators chew."

In the 1970s, Roth formally introduced the classic principles of clinical gnathology to orthodontics (orthodontic gnathology).[19-21] The notions and considerations of modern orthodontic gnathology are not based on principles of science and do not correspond to contemporary evidence-based thinking. There might not be a unified orthodontic gnathologic view, but it seems that the one established by Roth is by far the most notable.

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The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.
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Submitted, March 2008; revised and accepted, April 2008.
Am J Orthod Dentofacial Orthop 2009;136:322-30
0889-5406/$36.00

doi:10.1016/j.ajodo.2008.04.021

In general, the objectives of modern clinical and orthodontic gnathology are (1) to establish coincidence of maximum intercuspation (or centric occlusion) with centric relation (CR) in an anterosuperior seated condylar position, (2) to attain canine (mutually) protected occlusion (CPO) and anterior guidance, and (3) to mount pretreatment diagnostic casts on a fully adjustable articulator (with some also recommending pantographic tracings and many recommending deprogramming before taking centric-bite registrations).[19-24]

Gnathologists believe that failure to achieve at least 1 of these objectives will predispose patients to signs and symptoms of temporomandibular disorders (TMDs).[19-21] The purpose of this article is to dispel and debunk 10 myths of orthodontic gnathology. We have recently written on many topics dealing with orthodontic gnathology, and this article will help to more clearly elucidate and integrate the topics to explain the "big picture."[22-29] The 10 myths of orthodontic gnathology are (1) occlusion and condyle position are the primary causes of TMD, (2) orthodontics causes TMD, (3) the modern view of TMD treatment is based on gnathologic principles, (4) orthodontic gnathology recognizes and evaluates patients' parafunction and chewing cycle kinematics, (5) a "high" restoration provokes TMD, (6) TMD asymptomatic subjects with internal derangement (ID) need treatment, (7) CR is the key to the diagnosis and treatment of TMD, (8) CPO is the preferred functional occlusion type toward which to direct orthodontic patient treatment, (9) articulators play a critical role in orthodontic diagnoses, and (10) many valid scientific studies support orthodontic gnathology.

MYTH 1: OCCLUSION AND CONDYLE POSITION (CR POSITION) ARE THE PRIMARY CAUSES OF TMD

Occlusion and condyle position were once thought to be the primary causes of TMD.[19-22,30,31] The temporomandibular joint (TMJ) pain dysfunction syndrome was thought to be a distinct disease caused by 1 etiologic agent (eg, occlusion or stress; later, it was thought to be caused by an eccentric condyle position).[32-34] However, past etiologic agents such as occlusion and condyle position have not been proven to be the primary

cause of TMD.[35-49] Furthermore, TMD etiology and diagnosis are complicated because many diseases and dysfunctions can affect the TMJ complex and the neighboring structures of the head and neck.[23-26,50] TMD is now considered a collection of 6 subclasses of diseases and dysfunctions, with many causes for each subclass.[39,40] TMD treatments have changed from a dental-based model (ie, classic dental and jaw causative theories) to a biopsychosocial-medical model that emphasizes orthopedics, neuroscience, chronic pain theory, sleep neurophysiology, genetics, and psychosocial factors.[51-70] Because occlusion and condyle position are currently believed to have secondary roles in the etiology of TMD, these should reduce the significance of the orthodontic gnathologic view; gnathology is very much occlusion and condyle position oriented.[23-26,28,29]

MYTH 2: ORTHODONTICS CAUSES TMD

The orthodontic gnathologic view has argued that orthodontic treatment causes TMD from 2 possible perspectives. First, it causes TMD indirectly because nongnathologic orthodontists do not achieve a gnathologic occlusal finish and thereby produce an iatrogenic functional occlusion (ie, functional balancing interferences) and eccentric condyle (or CR) position that predisposes to TMD. The other possibility is that certain orthodontic appliances or techniques (eg, Class III mechanics, extractions, chincups, and so on) directly cause TMD.[19-22,28,29] However, the evidence-based view clearly is that orthodontic treatment does not cause TMD.[71-75] This should have been a tremendous wake-up call to the premises of clinical gnathology that are clearly dental-based. Parenthetically, because the data demonstrating that orthodontic treatment does not cause TMD are population-based, it is still possible for an occasional orthodontic patient's TMJ complaint to be caused by treatment.

MYTH 3: THE MODERN VIEW OF TMD TREATMENT IS BASED ON GNATHOLOGIC PRINCIPLES (DENTAL BASED)

Contemporary TMD treatment has moved away from a historic, mechanical, dental-based model, no longer involving occlusal modification or jaw-repositioning protocols.[50,65,66] The current evidence-based view of TMD treatment is now a biopsychosocial model.[51-64] Dworkin[76] stated that "the biopsychosocial model remains the best approach to gaining an understanding for how to integrate the host of biologic, clinical and behavior factors that may account for the onset, maintenance and remission of TMD, as well as for understanding how to make rational choices for treatment." Genetics related to pain and imaging of the pain-involved brain, central brain processing of thinking and emotions, endocrinology, and so on, are the exciting future. Treatments that are effective for all forms of chronic pain are equally effective in mitigating TMD pain.[54,63,65,66] Cognitive behavioral therapies and biofeedback are becoming the recognized initial and early treatment modalities for TMD.[51-53,55,56,63,64] However, there is support for the belief that occlusal splints (stabilizing-type splints are recommended) work best initially, and cognitive behavioral therapies and biofeedback work better later.[56,59-61] Cognitive behavioral therapies involve many treatments emphasizing stress reduction and cognitive awareness: education regarding mind-body relationships with stress management, relaxation training, distraction and pleasant activity scheduling to reduce the impact of pain on activities, cognitive restructuring, self-instructional training, and maintenance skills.[64]

MYTH 4: ORTHODONTIC GNATHOLOGY RECOGNIZES AND EVALUATES PATIENTS' PARAFUNCTION AND CHEWING CYCLE KINEMATICS

Two important aspects of human jaw function are not evaluated by the orthodontic gnathologic approach, particularly in relation to articulator mountings: parafunction and chewing cycle kinematics. The harshest and perhaps the most destructive occlusal forces are produced from parafunction—bruxing and clenching.[77] In this regard, it seems that it is not so much the type of occlusion or CR position that a TMD patient has as it is how the patient uses his or her teeth and jaws.[22-24] Patients with optimal and ideal static and functional occlusions (or condyle positions) have TMD, and vice versa. This stresses the importance of properly evaluating a patient's parafunction irrespective of the type of occlusion or condyle position. Incidentally, it was once incorrectly thought some 50 years ago during the "occlusionist" era (and still espoused today) that parafunction was caused by occlusal prematurities or interferences and that bruxing was nature's attempt to resolve the occlusal problems by grinding them away. Current evidence clearly supports the notion that parafunctional habits are basically a central nervous system phenomenon (mediated by the limbic system) and not of occlusal origin.[78-85]

The other aspect of human jaw function that is not evaluated by orthodontic gnathology (particularly by articulator mountings) is chewing cycle kinematics. It is understood that the chewing pattern shape as viewed from the frontal aspect is described as a tear drop.[2,4,43] There are about a half dozen different chewing

patterns.[2-4,23,24] This elliptical chewing motion can vary significantly from person to person.[2,4] Simply stated, some patients have a more vertical chewing pattern; in others, it can be more horizontal.[2,4,24] Chewing kinematics can vary based on several factors such as age, dental static occlusion, facial morphology, and so on.[2-4,43,85] For instance, in the developmental stage of the deciduous dentition, chewing pattern shape (judged from the frontal aspect) is very much lateral, with the mandible circling out on opening and circling inward (medially) on closing in a narrow and tight loop.[4] In the developmental stage of the permanent dentition, chewing pattern shape (judged from the frontal aspect) is not nearly as lateral; on opening, the mandible circles inward (medially) and, on closing, circles outward (laterally) in a larger loop than that in the deciduous dentition.[4] The length of the chewing stroke is approximately 16 to 19 mm with about 20 masticatory strokes before swallowing, taking about 12 seconds.[4] The consistency and shape of chewing kinematics vary for patients with deepbite malocclusions.[86] A logical hypothesis might be that those with more vertical chewing pattern shapes adapt best to CPO, whereas those with more horizontal chewing patterns function best with group function or balanced occlusions.[24]

With the above in mind, how does the orthodontic gnathologic approach (and articulator recordings and mountings) account for, and take into consideration, each patient's parafunction and chewing kinematics?

MYTH 5: A "HIGH" RESTORATION PROVOKES TMD

In 1995, Roth[87] wrote: "I would like to have the opportunity of placing a 'high molar restoration with balancing interferences' in the mouths of all who believe that occlusion has nothing to do with TMD." He used this intuitively appealing argument to support the notion that occlusal interferences are the primary cause of TMD. Certainly, it would be illogical to argue that gross occlusal disharmonies would not adversely affect the stomatognathic system and potentially have some negative impact on the TMJs. The modern evidence-based paradigm does not argue that occlusal interferences (this is in sharp contract to balancing contacts that are generally considered benign and typically do not need occlusal adjustments) are no longer a possible etiologic agent for TMD. The argument is that they now are not primary and have a lesser (secondary) role than once thought. Occlusal equilibration of gross occlusal prematurities is still within the realm of evidence-based care.[22-27,88]

The occlusal provocation studies (provoked or produced occlusal interferences in subjects) are equivocal as to the role of high restorations causing TMD.[89-92] TMD is certainly a potential consequence of a provoked high restoration, but so are headaches, tooth mobility, fremitus, and so on. Furthermore, most occlusal provocation studies are biased because they typically used dental students (or nurses) as subjects who had some notion of the possible outcome of the intervention. Curiously, some subjects in their control groups (with no high restorations) also had some of the same outcomes (eg, headaches and TMD) as those in the experimental group. Increasing the vertical dimension of occlusion does not generally negatively impact the TMJs unless there is a preexisting ID.[93-96]

MYTH 6: TMD ASYMPTOMATIC SUBJECTS WITH ID NEED TREATMENT

It has been estimated that as many as 30% of TMD asymptomatic subjects have ID.[97-99] The issue becomes whether TMJ ID predispose TMD asymptomatic subjects to TMD later on. And if this is true, the next question is whether these subjects need some form of dental or orthodontic treatment to mitigate future TMD.

A relationship (studies were associational and not cause-and-effect) has been established between TMJ ID and craniofacial morphology (although the differences were small).[100-102] TMJ disc abnormality was associated with reduced forward growth of the maxillary and mandibular bodies; for adolescents, there was reduced growth of the mandibular ramus.[100,103] It is not a leap of faith to believe that TMJ disc pathology can affect condylar growth.[100] It has been hypothesized that untreated (or inadequately treated) TMJ ID will most likely lead to pain, degenerative joint disease, compromised mandibular growth, and other negative conditions.[103,104]

There is general agreement that some consideration of this information should be factored into an orthodontist's thought process during treatment planning.[100-102] Nonetheless, the orthodontic gnathology camp (Dr Kazumi Ikeda[105]) argued that these subjects need treatment involving a nighttime occlusal stabilizing splint initially (in the past, the argument was for repositioning splints) followed perhaps by comprehensive orthodontic treatment. Roth[87] always contended that it is not just good enough to maintain a patient's status quo as related to TMJ health, but orthodontists have a higher obligation—to improve their patients' TMJ health status. It is believed that the best time to treat ID is early, before significant disc, skeletal, and occlusal changes occur while patients have optimal capacity for tissue repair and growth: ie, when they are young.[103] In addition, it is believed that most initially asymptomatic patients will become symptomatic usually after growth is

complete and when the TMJs have progressed to a nonreducing disc displacement and degenerative joint disease; at this stage, treatment would be significantly less effective.[103,104]

The contending view, and perhaps the logical and evidence-based view, is to "let sleeping dogs lie" and not to treat these patients because they are TMJ asymptomatic.[106,107] To treat these patients might do more harm than good, since there seems to be no practical and evidence-based treatment options for correcting these TMJ anatomic disc derangements. In addition, no scientific evidence shows that treatment will mitigate future TMD. Furthermore, the relationship of disc displacement to pain, mandibular dysfunction, osteoarthrosis, and growth disturbances is unclear.[106] Not all growing patients with disc displacements grow abnormally, nor do all patients with growth deficiencies have disc displacements.[54,107,108] Interestingly, it was also demonstrated that patients with moderate to severe TMD with associated disc displacement without reduction will improve without treatment over a 2.5-year period.[108] It would seem that, if disc displacement were a significant cause of mandibular growth deficiency, its signs and symptoms would be more common in this population than in the normal population. Finally, the relationship between disc displacement and TMD is complex; the causes are multifactorial (eg, trauma, genetics, stress, and pathology) and therefore cannot be simply explained by disc displacement.[107]

MYTH 7: CR IS THE KEY TO THE DIAGNOSIS AND TREATMENT OF TMD

Roth[87] stated: "If condylar position is not important in orthodontics, how did the term 'Sunday Bite' ever arise?" CR has been defined in so many different ways that it has lost credibility.[109] The concept of CR has historically and arbitrarily migrated from a posterior to a posterosuperior position to recently the most anterosuperior position of the condyles in the glenoid fossa.[23] It would be difficult to prove that any CR position is correct for all patients. There appears to be a range of CR positions. In this respect, one study found that 89% of condyles were not concentric.[110] It seems that mid to anterior sagittal CR positions might be better than a retruded position; however, in some patients, a retruded CR is the healthy norm.[99,111] The American Dental Association in TMD conference reports in 1983 and 1990 stated that "there is insufficient evidence that eccentricity of the condyles in the glenoid fossa will predispose to TMD or any other health consequence."[39,40] Johnston[18] sarcastically wrote about the absurdity of the many false notions of CR: "it could be argued that the progressive modification of Centric Relation (definition) has done more to eliminate centric slides than 20 years of grudging acquiescence to the precepts of gnathology."

The gnathologic view dictates that maximum cuspation, or centric occlusion, should be coincident with CR (anterosuperior).[2-4] In the early 1970s, Roth[19-21] argued that the correct CR position was a retruded, posterosuperior position. Early intraoral telemetry studies did not support the concept of a retruded CR.[14-17] Roth's view (and that of gnathology per se) was proven fallacious, and he recanted his previous view of retruded CR and adopted the contemporary view of anterosuperior CR.[19-23] The past notion of retruded (posterosuperior) CR by the orthodontic gnathologists was wrong despite the sad fact that many orthodontists blindly followed this thinking for decades. How much confidence and credibility should we have for orthodontic gnathology with its mired history and false thinking? Furthermore, what happened to orthodontic gnathology patients treated to the old retruded centric position? Did they develop TMD?

There are also many problems and issues related to CR records. As Nuelle and Alpern[112] wrote: "Doctor selected TMJ positioning at the dental chair is a blind procedure." Centric records have been shown to be somewhat reliable, but their validity has not been substantiated.[22,23] The orthodontic gnathologic view that claims that the Roth "power centric bite registration" seats patients' condyles in an anteroposterior CR needs to be verified by magnetic resonance imaging data. This becomes especially important because Alexander et al[113] clearly demonstrated in a magnetic resonance imaging study that condyles are not exactly located in the CR positions that clinicians believe them to be.

In addition, how do we know which of the many promulgated CR recordings (and positions) is correct? In this respect, there are at least 6 occlusal philosophies in dentistry (not limited to orthodontics).[28] Five of the 6 views can be considered gnathologically based views: classic gnathology (dating back to Stallard, Stuart, Thomas, and Lucia); bioesthetic dentistry (based on the work of Robert L. Lee); Dawson, Pankey Institute; neuromuscular school (Las Vegas Institute, Jankelson Myotronics view); and the Roth orthodontic gnathologic view. The sixth view is the nongnathologic view, which essentially supports taking a reliable centric occlusion (maximum intercuspation) bite registration as has been traditionally done for the last century. Of course, there can be many variations of this nongnathologic view. The various occlusal schools differ mainly on their view of CR—its position, but more so on how it is recorded. There are various philosophies

concerning manipulation techniques to record CR, deprogramming, and whether to use a facebow or an earbow transfer. So, each occlusal philosophy is competing with the others on the proper definition and correct recording technique of CR; this further complicates and muddles the issue of CR, making any 1 view less valid and important.

MYTH 8: CPO IS THE PREFERRED FUNCTIONAL OCCLUSION TYPE TOWARD WHICH TO DIRECT ORTHODONTIC PATIENT TREATMENT

We have discussed the problems with the notion of ascribing to the philosophy and concept of CPO for all orthodontic patients and treatments.[24] A summary of what we wrote in this comprehensive article follows. CPO, as the optimal type of functional occlusion to establish in orthodontic patients, is equivocal. Woda et al[114] wrote, after a comprehensive review of the literature, "Pure canine protection or pure group function rarely exists and balancing contacts seem to be the general rule in the population of contemporary civilizations." Modern evidence does not support a view that blindly adheres to the concept of CPO for all patients. One type of functional occlusion should not be considered optimal and preferred for all patients. CPO is merely 1 of a few possible functional occlusion schemes that might be attained with orthodontic treatment. Subjects with normal static occlusion (or Class I occlusions) tend to have balanced occlusion or else group function, and not CPO.[115,116] Group function and balanced occlusion (with no interferences, only balancing contacts) appear to be acceptable functional occlusion schemes, depending on the patient's unique characteristics. The stability and longevity of CPO is questionable. Reestablishing functional occlusion through orthodontic treatment back to the original type before treatment is problematic, since orthodontic treatment is often started before the permanent canines have fully erupted. It would also appear that consideration of chewing cycle kinematics, craniofacial morphology, static occlusion type, current oral health status, and parafunctional habits might provide important and relevant information about the most suitable functional occlusion type for each patient.[24]

MYTH 9: ARTICULATORS PLAY A CRITICAL ROLE IN ORTHODONTIC DIAGNOSES

We have written several evidence-based reviews that argued against the validity of articulators in orthodontics.[22,28,29] Therefore, this section will merely summarize some pertinent points in these articles. There are many types of articulators: arcon, nonarcon, fully adjustable, semi-adjustable, polycentric hinge, and so on. Alpern and Alpern[117] presented a strong argument that the polycentric hinge articulator might have some advantages over the others. Articulators can be useful for gross fixed and removable prosthodontic and orthognathic surgical procedures to at least maintain a certain vertical dimension while preclinical laboratory procedures are performed on dental casts. A main criticism of articulators in orthodontics is based on the study by Lindauer et al.[118] They found that, during opening and closing, the condyles not only rotate but simultaneously translate (move downward and forward); there is an instantaneous center of rotation. Articulators are based on the faulty notion of a "terminal hinge axis," which goes back to a half-century-old claim of Posselt, that, in the initial 20 mm or so of opening and closing, the mandible rotates similarly to a door hinge (and does not simultaneously translate).[118] However, Posselt formulated his view when CR was viewed as a posterosuperior, retruded (and not anterosuperior) CR position, and, during the recording of CR, distally guided pressure was applied to the chin, the most obvious reason for Posselt's finding of a "terminal hinge axis."[22]

Furthermore, Mohl[35] believed that the sensitivity and specificity of articulator-mounted casts in the diagnosis of TMD are poor. In addition, there is no valid evidence that performing articulator mountings improves patients' stomatognathic health. Interestingly, one of the most reliable and valid reports by the orthodontic gnathologic camp states that the difference between gnathologic and nongnathologic diagnostics is perhaps 1 to 2 mm, and this is only in the vertical plane.[119]

Also, articulators cannot accurately simulate jaw movements. Bite registrations are static, and patients are not asked to chew or function. There is no proven validity of bite registrations and where the condyles are located as a consequence of such recordings. Articulator mountings, for the most part, have not been shown to affect orthodontic diagnoses or treatment plans.[120] After all the effort involved in mounting and the attention paid to the minute details of occlusion and condylar position, little consideration is given to the physiologic adaptation of the dentition after posttreatment occlusal settling. In children, the glenoid fossa complex changes with growth; this implies that new mountings would need to be routinely performed throughout treatment. Although argued by orthodontic gnathologists as not true, it takes more time and cost to perform the mountings.[22]

MYTH 10: MANY VALID SCIENTIFIC STUDIES SUPPORT ORTHODONTIC GNATHOLOGY

We have published our criticisms of many orthodontic gnathology studies.[22,25,28,29] We would, therefore,

like to briefly address only the recent study of Cordray.[121] First, few studies are perfect and meet all requirements of great research. However, the study by Cordray (and others by orthodontic gnathologists) is more problematic than the typical published study.[29] Cordray seemed to believe that it was possible to evaluate and test the effect of "neuromuscular deprogramming" (with a tongue blade) on centric bite registrations. However, the study design precluded such an evaluation. Two independent variables (deprogramming and gnathologic bite registration) were confounded and commingled into 1 recording, so that the single, isolated effect of deprogramming alone (vs no deprogramming) could not be accurately determined. To effectively ascertain the true influence of deprogramming (if there was one), a third group would have had to be added—a gnathologic group without deprogramming. In addition, Cordray claimed to support the view that orthodontic gnathology (with articulators) is valid because it can help to better discern and elucidate the correct orthodontic diagnosis (by correctly determining the so-called correct centric bite registration). This conclusion was impossible for a number of reasons: not all the errors were accounted for, the large standard deviation was not explained, there were no blinding and no information on how the nongnathologic centric records were performed, and so on. Furthermore, Cordray did not mention the contradictory findings of Kulbersh et al[122] and Ellis and Benson.[120] More importantly, even if there is a difference in centric recordings when deprogrammed or gnathologically determined, there is the problem in assuming that the newer, deprogrammed record is better (more physiologic) than the original one.[22,23,123]

CONCLUSIONS

It is time to reconsider the validity of the age-old ideas of orthodontic gnathology that are based on rhetoric, blind faith, art, emotionalism, and practice management rather than on science and evidence. Orthodontic gnathologists have proved no health benefit to justify the many perfunctory exercises of the philosophy. The focus of orthodontic gnathology (and the clinical gnathologic view) was on the relationship of occlusion, then condyle position, and now TMJ disc position, dysfunction, and disease on the stomatognathic system (particularly regarding TMD). The view that occlusion and condyle position are the primary causes of TMD, and that diagnoses and treatments should be based on these notions, has been discredited. There is little to no evidence that treating subjects with TMJ ID will prevent or mitigate future TMD. If we are to embrace the concept of "evidence-based" treatment, the specialty will eventually have to carefully evaluate the quality of the evidence and its message within the context of a contemporary orthodontic practice. The dated ideas and art of orthodontic gnathology may actually be a waste of time for the average orthodontic patient. It is up to us to decide. In the end, the day-to-day application of any "philosophy" must ultimately measure up with literature that is pertinent to orthodontics. In orthodontics, everything "works" well enough to support a practice. Thus, the fact that something is used "successfully" does not mean that it is correct. Gnathology may make the orthodontist feel better; however, there is little evidence that the same benefits accrue to the patient.

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