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Treating temporomandibular disorders with permanent mandibular repositioning: is it medically necessary?

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In this paper, the authors review the rationale and history of mandibular repositioning procedures in relation to temporomandibular disorders (TMDs) as these procedures have evolved over time. A large body of clinical research evidence shows that most TMDs can and should be managed with conservative treatment protocols that do not include any mandibular repositioning procedures. Although this provides a strong clinical argument for avoiding such procedures, very few reports have discussed the biologic reasons for either accepting or rejecting them. This scientific information could provide a basis for determining whether mandibular repositioning procedures can be defended as being medically necessary. This position paper introduces the biologic concept of homeostasis as it applies to this topic. The continuing adaptability of teeth, muscles, and temporomandibular joints throughout life is described in terms of homeostasis, which leads to the conclusion that each person's current temporomandibular joint position is biologically "correct." Therefore, that position does not need to be changed as part of a TMD treatment protocol. This means that irreversible TMD treatment procedures, such as equilibration, orthodontics, full-mouth reconstruction, and orthognathic surgery, cannot be defended as being medically necessary. (Oral Surg Oral Med Oral Pathol Oral Radiol 2015;119:489-498)

Throughout the twentieth century, the dental profession adopted numerous concepts and clinical procedures involving repositioning of the mandible as part of dental treatments. In the case of dentulous patients, the major reasons offered for the manipulation of the mandible into a proposed ideal maxillomandibular relationship can be grouped into two major categories: (1) to achieve a repeatable mandibular position in cases of comprehensive dental treatment and (2) to prevent or manage temporomandibular disorders (TMDs). It is well accepted that dental procedures, such as full-mouth prosthodontic restorations, orthodontics, or orthognathic surgery, usually involve repositioning of the mandible into a repeatable maxillomandibular position that is different from the original relationship found in the individual patient.[1,2] However, when mandibular repositioning is performed as a preventive therapy or as a treatment approach in patients with TMDs, the procedure is performed on an assumption that the mandible is not in an ideal maxillomandibular relationship as a result of the existing static or dynamic occlusal relationships. These deviations from the "ideal" are assumed to be the fundamental cause for the development of TMD symptoms and signs.[3-5] The general implication has been that dentists should both recognize these deviations and correct them by performing various mandibular repositioning procedures.[3-7]

When discussing the management of TMD cases in terms of malposition of the mandible and the need for its repositioning, the apparent clinical success of a variety of mandibular repositioning procedures is often described in the dental literature.[8-10] However, even when a rationale for mandibular repositioning is offered, it is, in most cases, not discussed within the framework of *medical necessity*. This important concept[11] implies that the clinical procedure should be indicated and performed for the following reasons:

1. The medical condition (i.e., mandibular malposition) is generally recognized as a valid health problem or a disease.
2. The diagnostic tests used to assess whether the patient has this condition are valid with acceptable specificity and sensitivity.
3. The patient's condition will get worse unless a specific procedure is done.
4. The clinical procedure itself has specificity for addressing the patient's particular problem.
5. The procedure is clinically efficacious according to evidence-based criteria (i.e., not just a placebo effect).
6. The disease or disorder cannot be resolved by performing a less invasive procedure, thus justifying the invasiveness of the clinical procedure based on its benefit-to-risk ratio.

Statement of Clinical Relevance

This article discusses the controversial topic of managing temporomandibular disorders with mandibular repositioning. The authors argue that both clinical and biologic evidence are sufficient to reject this approach for the treatment of temporomandibular disorders.

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The term "medical necessity" appears often in the medical literature with regard to treating patients with various diseases or disorders. However, it is almost never defined in an operational manner. The authors were unable to find a complete or consistent definition for this term by searching medical dictionaries and PubMed or by using various Internet search engines (e.g., Google, Bing, Yahoo). The main source for the above list has been certain insurance company contracts, in which doctors and hospitals are informed about what will or will not be covered. The authors have modified those statements to develop the six-point definition presented here.

Mandibular repositioning procedures inevitably result in irreversible changes of the condyle or fossa and the interocclusal relationships that require subsequent extensive prosthodontic, orthodontic, and orthognathic procedures. Therefore, it is important to examine their medical necessity and their clinical validity if they are being recommended as preventive therapy or for active management of TMDs. It is the purpose of this paper to review the available scientific evidence related to these concepts and procedures of permanent mandibular repositioning.

PERMANENT MANDIBULAR REPOSITIONING PROCEDURES—HISTORY AND RATIONALE

Temporomandibular joint (TMJ) and mandibular anatomy and function have long been topics of great interest to dental scientists and clinicians. As new empirical and scientific evidence about these issues became available, different concepts of "ideal" dental occlusion or articulation (static and dynamic relationships of opposing teeth) have been introduced. Similarly, various concepts of "ideal" maxillomandibular skeletal relationships have been proposed over the years, especially with regard to condyle—fossa relationships. Although mandibular movements are incredibly complex, involving TMJs, masticatory muscles, and the occlusal or incisal surfaces of teeth, the endpoint of full closure into maximum intercuspation (MI) is a precise and repeatable position. It is this position that determines exactly where the mandibular condyle will be "seated" in relation to the articular fossa and eminence. Therefore, any modification of tooth relationships (occlusion) affects the position of the condylar head in the TMJ articular fossa.

There are several examples of dental conditions that require jaw repositioning as part of the therapeutic protocols. These include various malocclusions that need orthodontic and orthognathic treatments for correction. Also, many patients who have experienced major tooth loss, periodontal disease, and severe tooth wear will need reconstructive dental procedures to establish new occlusal relationships. Several concepts about how to achieve an "ideal" maxillomandibular relationship in those cases have been proposed.[1,12] Some of the recommended clinical protocols may involve the initial use of an oral interocclusal appliance to "free up" the mandible from its habitual MI position to establish the desired TMJ relationship.[13] Independent of the clinical procedure, the goal is to achieve stability, reproducibility, and predictability of treatment success in those clinical cases.

However, applying these repositioning concepts in preventing or treating TMDs requires a separate analysis of cause and effect. The premise that the etiology of these disorders is improper occlusal and maxillomandibular relationships goes back almost a century. That belief led to various dental procedures to prevent and treat TMDs by using the concept of an "ideal" jaw relationship. The first authors who wrote about this subject in the 1920s and 1930s[14-17] attributed ear symptoms and facial pain to the decrease of vertical dimension of occlusion, but it remained for Costen (1934),[18] an otolaryngologist, to place this concept in the spotlight. According to his theory of TMD etiology, which was not based on any specific research conducted by him or his colleagues, the decreased vertical dimension of occlusion leads to distalization of the condylar head within the TMJ. He attributed 11 painful as well as nonpainful otologic and facial symptoms to condylar pressure on the retrocondylar tissues of the posterior glenoid fossa. To reposition the condyles, he proposed a treatment approach that included opening the habitual vertical dimension of occlusion using an overlay dental prosthesis, covering posterior teeth only.

Interestingly, this concept emerged again many years later with the introduction of the mandibular orthopedic repositioning appliance (MORA) as a phase I treatment for TMDs.[19,20] A significant side effect of this treatment approach was intrusion of posterior teeth, which resulted in a bilateral posterior open bite. Advocates of this approach recommended crowning all posterior teeth, the extrusion of posterior teeth with the use of orthodontic methods, or long-term overlay wear as the phase II component of this treatment protocol.[20] Costen's anatomic concept was later rejected by Sicher,[21] Zimmerman,[22] and Christiansen et al,[23] who demonstrated that the proposed condylar pressure could not have occurred in vivo, given the normal morphology and physiology of the posterior aspect of the human TMJ.

Other authors[24] have discussed the decrease of the vertical dimension of occlusion in terms of loss of molar support. They claim that the loss of molars results in secondary osteoarthritis because of the increase of TMJ loading. However, their studies were done on skulls and autopsy specimens, so the changes observed might well have been the result of remodeling and adaptation. In addition, aging as a confounding factor was not taken into consideration, despite the fact that both tooth loss and secondary osteoarthritis increase with age. Epidemiologic studies of general populations found no evidence of an increased risk for TMDs or even of any tendency for more signs or symptoms of TMD in individuals with shortened dental arches.[25,26]

Vertical mandibular malposition concepts were soon followed by various concepts of "ideal" horizontal maxillomandibular relationships.[27] Throughout the twentieth century, one of the proposed ideal jaw relationships has been centric relation (CR), based entirely on how the mandibular condyle is anatomically related to the articular fossa. The most recent version of the *Glossary of Prosthodontic Terms* defines CR as the position of the condyle, with the intermediate zone of the articular disk interposed between the articular eminence and the condylar head when it is in its most superoanterior position within the glenoid fossa.[28] According to this ideal (which has been redefined several times in the prosthodontic literature), the maximum intercuspation (MI) of teeth should coincide with the initial point of occlusal contact (CO) when the mandible is in CR. Any MI that is different from CO results in a change in the ideal condylar position. Mandibular displacement from CR can occur in any direction, depending on the occlusal contact of the "interfering" cusps, but is most often *anterior*. According to clinicians who consider CR to be the true anatomic ideal, even a small discrepancy between MI and CO may result in an uncoordinated activity of both the superior and inferior lateral pterygoid muscles acting as antagonists to the activated elevator muscles. If this uncoordinated activity of the masticatory muscles persists, it may lead to chronic myofascial pain.[29] Interestingly, the orthodontic community came up with a quite different concept of mandibular displacement, in which the mandible was displaced posteriorly by a deep anterior overbite in some patients (the "trapped mandible").[30,31]

The concepts of occlusal dysharmonies causing mandibular malposition became even more popular as investigators proposed variations on the theme of increased muscular effort for coping with occlusal interferences.[27,32] Early research utilizing electromyography (EMG) seemed to show muscular hyperactivity leading to jaw muscle fatigue and pain.[33-39] However, subsequent studies showed that there was no consistent correlation between higher EMG activity and muscular pain.[40-42] Presuming that nocturnal bruxism was initiated by such occlusal interferences, the phenomena of occlusal "disharmony," bruxism, and myofascial pain became inextricably linked.[43] Not surprisingly, the treatments recommended for bruxism and myofascial pain involved changing the morphology of the interfering teeth and improving jaw relationships by means of equilibration, restorative treatment, and orthodontics.[44,45] Common to all these concepts is that it is the occlusal relationship that has disrupted the ideal maxillomandibular (or TMJ) relationship.

A direct approach for assessing mandibular horizontal position is based on the evaluation of sagittal TMJ radiographs, using specific anatomic parameters to fulfill the requirements of the "ideal" condyle−fossa relationship. Gerber[46] and Weinberg,[47] for example, were advocating that the condylar heads, as seen on sagittal radiographs, should be centrally located within the TM joints, whereas Gelb[48] proposed a more anterior position of the condylar head. However, these concepts were rejected later as several researchers showed that "displaced" condyles are commonly present in nonsymptomatic patients.[49,50] Therefore, the position of the condylar head relative to the glenoid fossa, as it appears on the radiograph, is usually of little clinical importance. With the introduction of arthrography and magnetic resonance imaging in the 1970s and 1980s, it became possible to visualize the TMJ disk during mandibular function. As a result, the treatment focus shifted from myofascial pain and condylar displacements to TMJ disk derangements.

Another concept of an ideal mandibular relationship that has lately gained attention is neuromuscular dentistry. Neuromuscular dentists advocate that the optimal position of the mandible can be determined and should be registered with the aid of various muscle stimulators, jaw trackers, and EMG devices.[51,52] In their view, the activated muscles of mastication determine the initial point of occlusal contact that represents the repeatable and the most physiologic mandibular position. Since these "ideal" neuromuscular jaw positions are always clinically different (usually anterior) from the habitual occlusal position (MI) of most patients, treatment of this occlusal discrepancy requires invasive and nonreversible dental procedures.[53-55] However, the advocates of this concept have failed to prove the validity of their assertions that such complex clinical procedures are either necessary or successful for the treatment of TMDs.[56,57]

THE ROLE OF ORAL APPLIANCES

Many of the mandibular repositioning procedures described above involve the use of an oral appliance both to relieve symptoms and to help in establishing a "proper" jaw relationship.[1,13] Several different designs of interocclusal appliances have been developed and used according to various theories of how they might work. The term "occlusal splint" is an indicator that such appliances were believed to be primarily directed at the dental occlusion. According to Ramfjord and Ash,[58] the most commonly used maxillary oral appliance (the stabilization splint or Michigan splint) could be utilized to:

1. Establish differential diagnosis for patients with TMD
2. Treat TMD symptoms (TMJ and muscle pain)
3. Relax muscles to establish optimal condylar position before definitive occlusal therapy
4. Treat patients with tension headaches
5. Temporarily disclude teeth for orthodontic purposes
6. Stabilize teeth after orthodontic treatment
7. Protect teeth against damage from severe bruxism
8. Stabilize mobile maxillary teeth and prevent eruption of mandibular teeth

An oral appliance that is placed between the dental arches alters the afferent proprioceptive feedback; this process is described by some clinicians as "deprogramming" the mandibular muscles.[59] Clinicians who believe that "occlusal disharmonies" cause TMDs, including improper maxillomandibular vertical and horizontal relationships, see the deprogramming as an essential part of a diagnostic and therapeutic process.[4] If the oral appliance has a flat occlusal surface, the mandible is free to move in various directions instead of always closing into a specific dental relationship. Thus, some clinicians believe this approach can be used to establish an ideal maxillomandibular relationship.

It is very likely that TMD symptoms and signs will improve in patients who wear oral appliances, as demonstrated in the dental literature. Many studies and systematic reviews have shown that the traditional stabilization splint can be used with great success in a conservative treatment paradigm that does not involve any permanent mandibular repositioning.[60] (NOTE: Several citations supporting the preceding two statements can be found on pp 159-162 in the AAOP Guidelines [60]). Although many clinicians have attributed these positive responses solely to changes in occlusal, condylar, and maxillomandibular relationships, it is important to note that the positive outcomes may be the result of a number of factors. In studies comparing those splints with repositioning appliances that purport to recapture a displaced disk, the outcomes generally have been very favorable for stabilization splints—despite the fact that they do not attempt to recapture the disk.[61-64]

However, there are two clinical scenarios in which certain TMD patients may be treated with an oral appliance that temporarily repositions the mandible forward.[3,60,65] One common situation is acute TMJ pain, which may arise from an external traumatic experience such as a blow to the face or an automobile accident. Acute pain also can occur as a result of an intrinsic event, such as a long dental appointment, oral intubation during general anesthesia, a sudden major disk shifting, or subluxation of the mandible while yawning. This kind of situation requires a combination of several treatment modalities (analgesics, ice packs, anti-inflammatory pills or injections, and major functional limitations), as well as the use of a forward-positioning oral appliance. This appliance can be worn 24 hours per day for several days while the inflammatory condition inside the sore joint is improving, and during that period it prevents the patient from closing the mouth fully. Within a reasonable time this appliance can be modified to become a regular stabilization splint that is worn at night only.

The second scenario is somewhat less common, but it does arise in clinical practice. A patient who has experienced jaw clicking may transition to intermittent "locking" of the jaw, in which the condyle cannot get past the posterior band of the articular disk; this is often a painful situation. It has been shown that a forward-positioning oral appliance can prevent this from happening in certain cases. Some patients need to wear that kind of appliance both day and night for a while, whereas others who wake up "locked" may find that nighttime wear is sufficient. The objective is to allow for continuous remodeling and shifting of the disk and its retrodiskal tissues while avoiding the painful episodes of limited opening.

In both cases, there is no intention to make the mandibular shift permanent, and careful monitoring is required to ensure that this is not happening as a result of patients overusing their appliances for an extended period. The ultimate goal is to allow the patient to return the TMJ to its original occlusally determined relationship.

It is often proposed that various types of oral appliances "unload" painful TMJs, to be followed by the second phase being the occlusal treatment that maintains the newly acquired condylar position.[66,67] Unfortunately, this concept violates the well-established experimental findings which have shown that the human TMJ is *always* under a functional load.[68]

Obviously, the presumed causality between a predefined "ideal" maxillomandibular relationship and various types of TMD signs and symptoms has had a powerful impact on the dental profession. Throughout most of the twentieth century, a majority of dentists were proponents of occlusal modification and jaw repositioning concepts, and their patients with TMDs were treated accordingly. However, basic science and clinical research during the last three decades has demonstrated that most of these concepts are either flawed or completely incorrect. For example, many well-controlled studies have shown that almost every type of occlusal and maxillomandibular relationship can be found in equal proportions among patients with TMDs and nonsymptomatic patients.[69,70] As a result of this evolving knowledge, the early mechanistic theories of TMD etiology have been replaced by more complex and multifactorial etiologic concepts of how patients develop TMDs.[71-75] This shift ultimately led to a significant change in thinking about TMD treatment paradigms and procedures. Irreversible occlusal modification and jaw-repositioning procedures were replaced by more conservative treatment modalities that relieve joint and muscle pain and dysfunction. In addition to the oral appliances discussed above, most muscular and joint TMD signs and symptoms can be successfully managed with a combination of patient education, recommendations for home care, cognitive behavioral therapy, analgesics and other medications, and professional physical therapy. Clinical research conducted around the world in the past 25 years has demonstrated the effectiveness of this conservative approach for managing TMDs.[60] As a result, it has become recognized as the twenty-first century "standard of care" by several national and international organizations.[76]

As presented in the next section, understanding the biology of the three components of the masticatory system is crucial for appreciating how they work throughout a lifetime. The masticatory system constantly needs to adapt to a wide variety of continuously changing environmental challenges. This process is referred to as *homeostasis*, and it is important to know how the masticatory system is capable of meeting those challenges. Although it is possible to exceed the adaptive capacity of this or any biologic system, the masticatory system, in general, has been shown to be remarkably adaptive. Though there are still many dental clinicians and institutions who argue for the need to permanently reposition a mandible, either for optimal health purposes (prevention) or for TMD treatment, it is unlikely that a case can be made, on a biologic basis, for the *medical necessity* of changing jaw relationships permanently in either asymptomatic individuals or symptomatic patients with TMDs. Instead, we intend to demonstrate that, in general, homeostatic activities constantly keep the mandible in an appropriate position relative to the maxilla (occlusion) and the skull (TMJ).

HOMEOSTASIS OF THE CRANIOFACIAL COMPLEX

It is now generally accepted that there are significant intra- and inter-individual variations of human craniofacial morphology and mandibular function. These include variations in spatial relationships of the dental, TMJ, and muscle components. At the individual level, there is a continuously changing relationship between morphology and function of the craniofacial system. Just as mandibular function influences long-term processes, such as growth, development, and modeling and remodeling of the TMJ, it also affects short-term changes in the morphology of teeth and the muscular components of the system.

Beginning with the growth and development of the stomatognathic system, these tissues interact in a dynamic equilibrium that is constantly responding to functional forces. For example, the undifferentiated mesenchymal cells, influenced by genes and environmental cues, will proliferate, differentiate, and migrate as they produce structural morphologies such as the condyle and fossa, the masticatory muscles, and teeth. Simultaneously, the surrounding mechanical forces continuously affect the tissues and cells by producing mechanical strain, which in turn regulates gene expression as well as cell proliferation, differentiation, and maturation. This interaction does not cease when growth is complete; instead, it continues as required to adapt to various environmental forces. This process in the adult is referred to as *homeostasis*, and it involves the three major components of the stomatognathic system, namely, bone, muscle, and teeth, as well as all of their investing tissues.

Temporomandibular joint

In adults, the components of the TMJ, as in any other joint, are continuously responding to environmental challenges even after the TMJ reaches its adult form (around the age of 20 years).[77-79] This adaptive process is called *remodeling*, and it maintains the equilibrium between form and function.[80] It is characterized by changes in the cellular composition of the fibrous articular layers of the condylar head and articular eminence. As an adaptation to increased biomechanical stress, predominantly fibrocyte-like cells are eventually replaced by cartilage cells. In addition, the proliferative layer covering the surfaces of both the condylar head and the articular fossa has the ability to produce cells that are capable of either chondrogenesis or osteogenesis. The cartilage layer thus produced is superior to bone in withstanding the compressive forces that result from increased loading. This type of adaptation of the fibrous articular tissue is not unique to the TMJ, but can be found wherever membranous bone is under intermittent loads.

As the maxillomandibular relationships change over time as a result of tooth wear or loss, the applied loads on the respective sides of the TMJ increase, and the thickness of the articular tissues change accordingly. Thus, the overall morphology of the condylar head and the articular fossa or eminence, as well as the spatial relationships between those structures are continuously undergoing adaptive changes, as readily observed by common imaging techniques.[81-84] For example, there is evidence that changes in form of the articular eminence occur following loss of the posterior teeth, with resulting loss of occlusal support.[85,86] Similarly, associations have been made between findings of occlusal attrition and abrasion and changes in form of the condylar head.[87-89] The sites where TMJ remodeling takes place most frequently are the posterior and lateral aspects of the articular eminence, and the anterosuperior and lateral parts of the mandibular condyle.[68,78,90,91] These changes, in most cases, occur without any pathologic processes and are painless. The remodeled joint morphology thus enables continuous function in spite of changes in the amount and location of biomechanical stress. This explains the readily observed intra- and inter-individual variations in the spatial relationships of the TMJ components in the general population.

Muscles

The process of developing a close integration of morphology and function of the masticatory muscles during growth continues throughout life as part of homeostasis. Clinically, a good example of adaptability is seen in the changes observed in the masseter muscle after an increase in vertical dimension of occlusion.[92,93] Similar to all skeletal muscles, craniofacial muscle fibers contain contractile proteins that are responsible for developing tension and ultimately occlusal force. The amount of tension that each muscle fiber produces depends on the length of the sarcomere, which is the basic contractile unit of a muscle fiber. There is an optimal length of the sarcomere, at which a muscle fiber produces its maximum tension.[94] Because of the different orientation of muscle fibers within the multi-pinnate muscles (e.g., masseter, temporalis), any overall change in muscle length differentially affects the change of sarcomere length in various regions of the muscle. Increasing muscle fiber length permanently, as in the case of increasing the vertical dimension of occlusion, leads to an initial increase of sarcomere length and a subsequent decrease in muscle tension.[95,96] However, as part of the adaptation to the new working length, muscle fibers have been observed to alter their numbers of sarcomeres in series by adding new ones at their ends.[97] The result is that each muscle fiber reaches an optimal functional length that produces maximum tension (force). In addition to the adaptation of the muscle fiber itself to its new length or orientation, other changes occur in the area of each muscle's connective tissue attachment to the bone.[98] Both processes work together continuously to maintain homeostasis of the masticatory muscles in order to preserve their optimal function.

Another important clinical example of masticatory muscle adaptation is observed in patients with myofascial pain, which can significantly alter mouth opening as well as the extent of functional and border mandibular movements, including vertical dimension of rest. Previous theories of lactic acid buildup and vicious cycles of pain being the causes of muscular pain and dysfunction have been rejected. Instead, it is now well accepted that changes in the function of masticatory muscles are the result of muscle adaptation to pain. The pain-adaptation model explains the EMG activity of painful masticatory muscles while acting as agonists (decreased activity) or as antagonists (increased activity).[99,100] At the occlusal level, masticatory muscle pain can produce detectable changes in the occlusal contacts, which range from interferences in maximal intercuspation to more significant changes in occlusal relationships, such as unilateral or bilateral open bites. Thus, the occlusal changes seen in patients with myofascial pain are generally the consequences of the pain condition rather than its cause. These changes tend to resolve as the pain is successfully managed.[101,102]

Teeth

Before the eruption of permanent teeth, the deciduous dental arches must undergo significant modifications to accommodate the differences in the mesiodistal dimensions between deciduous and permanent teeth. During the eruption of permanent teeth, the maxillomandibular relationship is being maintained by occlusal morphologies of the first permanent molars that erupt distal to the second primary molars. As the counter-clockwise rotation of the growing mandible continues, the newly erupted permanent molars start to change their positions relative to the midline and the base of cranium. This change includes a positive settling relative to their opposing teeth, producing the strongly interdigitated relationship of normal human posterior teeth.

In adults, a mesial positional change of teeth continues to occur as the result of occlusal and proximal tooth wear.[103] The change in occlusal morphology is the result of *abrasion* (functional wear of the occlusal surfaces, which reduces crown height and alters occlusal morphology), and *attrition* of the proximal surfaces, which reduces the mesial−distal dimensions of teeth and the length of the dental arch. These two normal biologic processes are referred to as *compensating eruption* and *mesial drift*, respectively.[103] Both processes are responsible for maintaining the continuity of the dental arch and the vertical dimension of occlusion. With the progressive use of teeth throughout life during function and parafunction (e.g., bruxism), the occlusal morphology becomes flatter. In some cases, the amount of occlusal wear is so extreme that some vertical dimension is "lost"; however, this type of loss has not been scientifically related to the development of any jaw pain or dysfunction.

On the basis of the above, it is important to recognize that any permanent change in morphology on the occlusal level affects growth, development, and remodeling of the TMJ and the associated masticatory muscles. Therefore, the current occlusal and TMJ relationships in every individual are the product of a lifetime of homeostatic adaptation of all three components of the masticatory system.

CONCLUSIONS

This is the first paper that addresses the issue of mandibular "malposition" in terms of homeostasis and adaptation. The biologic evidence presented here regarding anatomic and functional balance among teeth, muscles, and jaw joints throughout life is overwhelming. It tells us that the masticatory system is capable of growing and adapting continuously throughout the human lifespan. For example, the masticatory system responds favorably to almost all types of irreversible dental interventions. Regardless of whether a single tooth restoration or a full-mouth reconstruction is provided with fixed or removable prosthodontics, or whether a complete occlusal relationship change is produced by orthodontics, the masticatory muscles and the TMJs remodel accordingly. The most striking example of this adaptability is the period after orthognathic surgery, which results in the most dramatic changes in mandibular position and occlusal relationships in a very short time, and yet successful adaptation after those procedures is seen in almost all of those patients.

The concept of mandibular repositioning as a preventive or treatment approach for TMDs was evaluated within the context of the six criteria of *medical necessity* outlined in this paper. If the occlusal, muscular, and condyle−fossa relationships are constantly adapting to the current function of the masticatory system, then each individual's current maxillomandibular relationship is, by definition, a biologically correct relationship. Although it is possible to exceed the adaptive capacity of the masticatory system, it has been shown that the system is remarkably adaptive. Therefore, the term "mandibular malposition" cannot be regarded as a valid and recognized concept to explain the etiology of a TMD that requires treatment with some repositioning procedure. Consequently, that term does not meet the first of the six requirement of medical necessity (i.e., the condition being treated must be a valid and recognized medical problem).

In addition, there are currently no clinical or technological tests, including the analysis of occlusal contacts, sonography, vibratography, thermography, jaw tracking, electromyography, electrical stimulation, or any type of imaging, that can successfully predict which asymptomatic patients will eventually develop a TMD. The same is true for their use in patients with current TMD symptoms for the purpose of deciding who needs to have their mandible repositioned permanently. As diagnostic, screening, discriminatory or monitoring tests, they all lack theoretical as well as measurement and diagnostic validity, which results in their having high sensitivity but very low specificity.[104] Whenever a decision is made to attempt to reposition the mandible, most of the clinical procedures that are available to the clinician lack the specificity required to address only the targeted component of the masticatory system. For example, treatments using oral appliances or occlusal adjustments with the aim to change the interocclusal relationship will inevitably change the condyle−fossa and muscular relationships and thus affect all the other components of the masticatory system. It is this complexity that confounds the attempt to understand what may ultimately be responsible for the apparent treatment success of so many different kinds of occlusal interventions.[105]

It is therefore important to evaluate all TMD treatment outcomes by applying one's knowledge of the natural history of those disorders, including the role of homeostasis in this process. As more information regarding the etiology and pathophysiology of TMDs, especially the masticatory muscle disorders, has become available, it has become abundantly clear that the cost−benefit ratio of conservative treatment approaches significantly outweighs any type of mandibular repositioning procedure. Consequently, the therapy for most TMD problems should be selected by matching the clinical diagnosis with the appropriate conservative TMD treatment protocol within a biopsychosocial framework, as described in several published guidelines.[60,106] Those treatments should target the painful tissues, with some directly affecting the underlying pathophysiology of the pain (treatments) and others being palliative (managements).

In summary, we have concluded that permanent mandibular repositioning procedures do not fulfill any of the six criteria of *medical necessity* as the appropriate and medically acceptable treatments or management options for patients with various TMD conditions. This conclusion also has ethical implications, as discussed in the recent paper by Reid and Greene.[107] According to ethical standards, a physician is expected to offer patients the best treatment options with the least risk possible, even if that approach results in less ideal financial returns for the practitioner.

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