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Conceptual Paper

New Concepts in Dentistry: Functional Relation (FR) or Functional Position (FP) and Functional Occlusion (FO) - Concepts Descriptions and Instantiations

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Abstract

Mandible is a mobile bone and the position of the condyle inside the articular fossa, determining occlusal relations, continues to be a master summit of discussion and confusion in Dentistry. Terms such as Centric Relation (CR), Centric Jaw Relation (CJR), Centric Occlusion (CO), Occlusion Habitual (OH), Maximum Intercuspal Habitual (MIH), Maximum Intercuspal Contacts (MIC) are unclear, mainly because many authors tried to explain these topics creating several definitions over a hundred years, adding more misunderstandings to the problem. Several descriptions which were given in the past for CR are of no agreements up to today. The purpose of this article is to review superannuated terminologies related to dental occlusion and revisit already existing state-of-the-art concepts and terms published by the same author in 2014 [1], to put an end to dentists misperceptions, elucidate gray teachings on this subject in dental schools and eliminate the confusion in dental students' minds. Those above terms were reduced to only two from which the whole practice of Dentistry should be based upon. Extensive descriptions of the proposed new terms are presented for better understanding their applicability, two clinical case reports, revealing intrinsic conditions on patients with Temporomandibular Joint (TMJ) disorder. Ultimately, it can be said that patients with malocclusion not always have associated TMJ disorders, but TMJ diseases always result in some type of clinical malocclusion. A patient suffering from TMJ internal disturbance most recurrently have a concomitant external disorder, as well.

Keywords: *Centric Relation; Centric Occlusion; Maximum Intercuspal Habitual; Functional Relation; Functional Position; Functional Occlusion*

Abbreviations

TMJ: Temporomandibular Joint; CDS: Condyle-Disc System; CDFS: Condyle-Disc-Fossa System; CR: Centric Relation; CJR: Centric Jaw Relation; SCP: Seated Condylar Position; CO: Centric Occlusion; OH: Occlusion Habitual; MIH: Maximum Intercuspal Habitual; MIC: Maximum Intercuspal Contacts; FR: Functional Relation; FP: Functional Position; FO: Functional Occlusion; MM: Masticatory Musculature; MIO: Maximal Incisal Opening; OTO: Orthodontic Treatment Objectives; STO: Surgical Orthodontic Objectives; AP: Anteroposterior; VSP: Virtual Surgical Planning; 3D: 3-Dimensional; 2D: 2-Dimensional; SPECT: Scintigraphy or 3-Phase Scan; CT: Computed Tomography; MRI: Magnetic Resonance Imaging; SS: Stomatognathic System

Introduction

This article is based on a textbook publication of the same author [1], which masterpiece is called Surgery of the Temporomandibular Joint - TMJ, published in Portuguese.

It is known that one of the main functions of the stomatognathic system is to promote a chewing capacity to not overload the digestive system, despite digestion starts in the oral cavity with the action of saliva amylase. Logically, chewing will be more efficient when there is an ideal dental occlusion. However, for a good masticatory function to exist, both stable muscular and skeletal centric stops, maximum intercuspal contacts for greater crushing capacity, efficient eccentric contacts so that the teeth are capable of cutting and tearing food and the absence of minimum occlusal interferences are necessary.

The definition of Centric Relation (CR) has undergone a varied number of interpretations in recent decades, starting in 1926 and 1929 [2,3]. However, all of them were not concerned nor explaining where the Temporomandibular Joint (TMJ) disc anatomically should be positioned on the relationship between condyle and articular fossa. Those definitions have always been related to a static structure, of minimal or no clinical value, concerned only with the isolated seated condyle aspect and not with the Condyle-Disc System (CDS). But mandible is not a mobile structure and mandibular teeth are half part of the occlusion. This dissociation should have never occurred, but it happened probably was due to lack of applicability of an already existing knowledge.

For some authors [4-6] CR was a non-forced condyle position, where the mandible should be in maximum retrusion. It was stated [7] that CR was equal to the resting position, however another researcher [8] opposed to this concept, claiming that CR could never be a position of mandibular rest.

The articular disc was first mentioned in the CDS in 1933 [9], considering that the ideal position for the condyles in CR was when they rested close to the inferior edge of the articular eminence, with the articular disc serving as a 'damper cushion' between the condyles and the posterior portion of the articular eminences.

An article published in 1938 [10] disagreed with all those previous authors, maintaining a concept that the maximum retrusion of the condyle would be a forced position. Nevertheless, it was understood that this relationship was a required physiological position for appropriate joint rest [11].

Later, in 1969 [12], despite of understanding that CR was a position of maximum retrusion, created the term 'freedom in centric', whose theory proclaimed that the RC of the condyle was not just a specific point in the TMJ, but rather a biological area. An interesting concept but without major clinical implications.

In 1985 [13] it was mentioned that "...clinical CR is functional when the joint spaces are symmetrical and both condyles are concentrically positioned in the upper portion of their respective glenoid fossae...".

Finally, in 1983 [14], 1985 [15-17], other authors stated that CR was the most anterior and superior position of the mandible heads within the articular fossa, arguing that this was an anatomical and functional reference position for locating the balance of the condyle on the posterior aspect of the articular eminence.

It seems that only later publications brought into attention the articular disc in this Condyle-Disc-Fossa System (CDFS).

These authors [18-37] described the position of the condyle and disc within the articular fossa in normal states.

Their perception can be translated into this, the normal and physiological position of the disc when the mouth is closed rests on the condyle, where its posterior band must be ten degrees posterior to the condylar center (12 o'clock position) and intermediate zone of the disc in contact with the most anterosuperior portion of the condyle.

When this relationship is anatomophysiological normal, the condyle is centered within the joint cavity, with the anterior, superior, and posterior spaces preserved and harmonious, as seen on figure 1a. Not all joints exhibit the described position, but even a slight displacement of the intermediate zone to the anterior aspect of the condyle is considered displacement of the articular disc. On Maximum Incisal Opening (MIO) the disc in its physiological position must be located between the posterosuperior surface of the condyle and the convex surface of the tubercle of the temporal bone [31,38), as seen on figure 1b.

Nevertheless, the notion that CR is the relationship between mandible and maxilla when the CDS, appropriately aligned, is in the most superior position of the condyle seating against the eminence, regardless of the position of the teeth or the vertical dimension, arises only in 1989 [39].

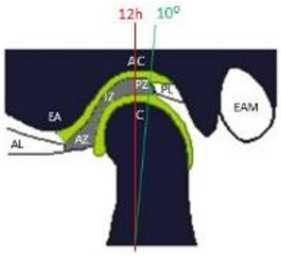

Figure 1a: *The drawing schematically shows the normal anatomo-functional relationship of the TMJ in closed mouth, where C: Condyle, AZ: Anterior Zone of the Articular Disc, IZ: Intermediate Zone of the Disc, PZ: Posterior Zone of the Disc, AC: Articular Cavity, AL: Anterior Ligament, PL: Posterior Ligament, AE: Articular Eminence, EAM: External Acoustic Meatus. The regions in green represent the upper and lower joint spaces. The red vertical line divides the condyle at 12 hours. The green line marks ≈10º posterior to the midline.*

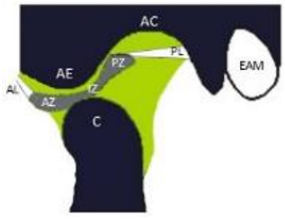

Figure 1b: *The drawing schematically shows the normal anatomo-functional relationship of the TMJ mouth open. The abbreviations are the same as the ones of figure 1a.*

From this concept it was acknowledged a resulting occlusion called Centric Occlusion (CO) which would be the positioning of the mandibular condyle within the articular fossa and dental and craniomandibular position coincides [40], but he never considered the importance of the articular disc as previously described [39].

It can be inferred from these observations that CO is a clinical concept that aims to offer a reproducible arch relationship during the reestablishment and adjustment of occlusion to obtain a maximum occlusion, giving rise to the term Maximum Intercuspal Habitual (MIH). Or that this type of maximum interdental occlusion refers to a relationship between mandible and maxilla when the teeth would be in maximum contacts, regardless the alignment of the CDS [41].

All these definitions are abstruse when put together and do not help the dentist to determine clear and precise parameters for his clinical work, which could involve dental restorations, prostheses, and orthodontics. And even less to correctly diagnose TMJ problems, as up to now, this joint has minimal or no importance in dental clinical practice.

Giving an example to illustrate Dentistry problems in the area of diagnosing TMJ disorders, occlusal or malocclusion dysfunctions, it is possible to cite a research done in 2006 [42] who, using an articulator to assemble plaster models of his patients, discovered the existence of discrepancies between the occlusion evaluated in the initial consultation of his patients, which he called MIH, to another position determined as CR, after neuromuscular deprogramming on those patients. Initial and post-neuromuscular deprogramming occlusal discrepancies were considerable.

However, omitting this extremely important detail, the condylar discrepancy found was significant in the vertical ≥ 2 mm, horizontal ≥ 1.6 mm, and transverse ≥ 5 mm directions in 57.5% of asymptomatic patients, altering the two occlusal dental relationships found.

Upon revision of the scientific literature on occlusion, it seems that the expressions CO and MIH emerged to explain the dysfunctionality in which a certain patient develops two distinct bites; the well-known and much debated term dual bite.

Some authors in 1979 [43], described the functions and dysfunctions of the masticatory system in patients with dual bite, proving that when it is present, TMJ diseases are concomitant.

Centric relation versus functional relation or functional position

Centric Relation (CR) or Seated Condylar Position (SCP) have been described in technical literature in three different ways: anatomical, conceptual, and geometric.

This position determines that the condyle must be seated within the articular fossa. Without a doubt, this position can even be called CR, but it will never be an articular condyle functional relationship with the disc because it does take into consideration its physiological (healthy) position. Noticeably a CR, but never a functional one.

The new name proposed in 2014 [1], Functional Relation (FR) or Functional Position (FP) is an anatomo-physiological concept of clinical application, with the diagnosis established via patient examination and, inevitably, by Magnetic Resonance Imaging (MRI). If other conditions are present inside the joint, new images of this structure, using Computed Tomography (CT) and Scintigraphy or 3-phase scan (SPECT) are indicated.

Therefore, this parameter is the clear determination it is not enough for the condyle, just one of the TMJ structures, to be inside the articular fossa, but it must be in a such position that maintains harmony of the anterior, superior and posterior joint spaces, the correct disc positioning, not causing compression of the bilaminar zone nor strain on the articular disc that would force the condyle and/or the disc itself to move out of its anatomo-physiological position.

When this relationship between CDS and articular fossa is present with healthy structures, determining a FR or FP, the desired occlusion must necessarily be Class I, as described in 1899 [44].

If these relationships are altered, the existence of a pathological process involving the TMJ and/or a dentoskeletal deformity is undeniable. Therefore, the normal relationship of these structures within the joint must the desired for all indicated dental procedures, obviously, those involved with occlusion, whether during growth and development of an individual's face, as well as in his adulthood.

During growth and development of facial structures, dental arches, soft and hard tissues tend to get harmonized establishing a physiological pattern, so that the entire stomatognathic system (SS) is functional without causing direct damage to the integrated structures of the SS. However, this is not always possible, as internal (genetic) and external factors (acquired habits, trauma, etc.) will be acting independently and intensely on the entire SS which might cause significant changes [1].

In adulthood, loss of teeth, poorly performed dental restorations and/or prostheses, especially extensive oral rehabilitation, and even substandard orthodontics, can cause significant changes in the equilibrium of all organs involved in the TMJ. Often, a change in harmony and/or balance of the SS, associated with other factors such as heredity, stress, psychological problems and activities which may be overwhelming for one of the components of this complex system, results in dysfunction, pain, and structural changes, as shown in figure 2.

Therefore, the concept of FR or FP is not just a clinical view of an isolated position of the condyle within the joint cavity when the mandible is manipulated by the dentist, as it would be possible to create an anatomo-functional dissociation, but it is a new philosophy that determines the preservation and/or reestablishment of harmony of all structures involved in the TMJ when the focus is dental occlusion and vice versa.

Hence, every dental surgeon, and even more so the prosthodontist and orthodontist, must exactly understand this concept and apply it consistently in their daily practice to prevent joint diseases, because the main cause of internal TMJ dysfunction is discal displacement, as defended by several authors [18,24,45-58].

Centric occlusion and maximum intercuspal habitual versus functional occlusion

At the American Association of Orthodontics (AAO) congress in 2006 [59], one of the main speakers on the orthodontic course, upheld the need for reviewing Angle's definitions of Classes I, II and III, and arising malocclusions, when a 'normal' standard occlusion

Figure 2: Longshoreman who has been placing heavy bags against the right side of his mandible for many years to help balance their weight, developed considerable ipsilateral masseteric hypertrophy.

is intended by this specialty. The lecturer justification was that the specialty should not be centered on a bygone classification to conclude whether an occlusion is within or outside the normal range, but rather find a stable orthodontic occlusion which is suitable for the patient. This researcher's position is risky and, in fact, unreasonable, as the knowledge brought by Angle is a firm foundation for clinicians to have a standard for diagnosing occlusion, preventing periodontal diseases resulting from poor dental positioning and ideal dental aesthetics.

The most important aspect of orthodontic correction is not, under any circumstances, dental aesthetics as proclaimed by some experts. Without a doubt, it is the coordination of teeth positioning with normal mandibular function, as defended by several authors [60-82].

The term Functional Occlusion (FO) refers to the perfect dental intercuspation of a given patient, with Angle Class I occlusion of canines, aligned and leveled teeth anchored within the alveolar medullary bone, and absence of occlusal interferences on the anterior guide and left and right literality, when the FR or FP is present in the TMJ. If a joint disease is present, modifying the anatomical relationship between CDS and articular fossa, evidenced by MRI, the occlusion will not be functional in any way. It may even be called occlusion habitual (OH), CO or MIH, but never FO.

And why is this tooth-CDS relation necessary? Because the description of a dental occlusion unavoidably includes the condylar positioning resulting from the intercuspation of teeth and not a transferred mechanical and static position with plaster models mounted on an articulator in CR, which fixed procedure in 1995 [76], in 1996 [83], and in 1999 [84], as this practice would better help the diagnosis of a malocclusion or even determine a diagnosis and treatment plan.

A pilot study in 2001 [85] showed that fabrication of an occlusal appliance (splint), bite registration, and transfer to an articulator with an arbitrary earpiece facebow does not yield clinically relevant benefits.

In fact, the assembly of a dental occlusion in an articulator, after transfer via face bow, whether for diagnosis or treatment in the specialties of orthodontics, dental prosthesis, implantology, and orthognathic surgery planning for patients with dentoskeletal deformities, no longer has any clinical value and the use of these devices must be abandoned in modern Dentistry.

Dental models, face bow, and articulator have nothing to do with: a) speech, b) fit and comfort of the prostheses, c) ridge morphology, d) facial contours, e) color of the teeth and denture base, f) arrangement of the artificial teeth, g) chewing efficiency stabil-

ity, and h) psychological aspects of prosthodontic and orthognathic treatments. Students', professors', schools', patients', and taxpayers' time and money can be saved by no longer teaching this 141-year-old treatment procedure [86].

A new era in prosthodontics was established in 2018 [87], in 2022 [88], and in 2023 [89,90], with intraoral scanning, cone-beam computed tomography scan, and virtually transferring 3-dimensional (3D) representation to digital articulators, validated the digital workflow for transferring intraoral and extraoral data for completely edentulous patients, having face bow and articulator retired for good.

In patients with adequate occlusion, when their mandibular movements are performed in a harmonious and non-traumatic way, the positioning of the condyle within the joint cavity seems to be more appropriate, but only when the disc is in its anatomo-functional position. Any acquired or developed malocclusion can result in a traumatic relationship between CDS and articular fossa. For that reason, dental occlusion must be a functional occlusion, resulting from the condylar FR or FP, and not a centric one.

Implications of the functional relation or functional position and functional occlusion - diagnoses and treatment

However, a question persists, what real change these new concepts bring to dental practice?

They completely and radically change dentistry professionals' notion and attitude towards the TMJ and the concept they have on normality for this anatomical organ. Also, the orientation of restorative dentistry, prosthetics, and orthodontics because this new holistic view cannot, in any way, separate the basic notions of dental occlusion from this new philosophy of treatment.

These terms FR or FP and FO are interconnected and cannot exist isolated except for unfolding the knowledge and study of their details. As a result, advancing in the specific expertness of dental occlusion and TMJ, as they are bind together, it is possible to correctly state that the term CO and OH no longer have their importance and a new term appears, the FO, which is an Angle Class I dental occlusion, with bilateral canine relationship[1], coincident with the FR or FP. Anything outside this concept is a malocclusion and/or a joint disease, respectively [1].

The term Maximum Intercuspation Habitual (MIH) also no longer has any value, as in fact, this dental relationship is a malocclusion that needs to be treated, whether by orthodontics, prosthetic rehabilitation and/or TMJ and/or orthognathic surgery when indicated.

Therefore, what is important in the diagnosis for treatment of patients with joint dysfunction is the relationship between dental occlusion and a healthy TMJ. Furthermore, an extremely relevant aspect is the fact that it is easier for a dental student to learn the meaning of the terms FR or FP and FO than the confusing and outdated interpretations of CR, CO, OH, SCP, MIH.

A very simplistic concept for future professionals in Dentistry regarding this new terminology is to teach them that FR or FP is the harmony that must exist inside the TMJ and its structures, while FO is the occlusal relationship in Angle Class I of canines.

Diagnoses and clinical management

If a patient clinically presents an Angle Class I dental occlusion, but a FR or FP is not present, the diagnosis of a joint disease will be diagnosis, and the treatment must be the reestablishment of harmony in the TMJ and/or surgical correction of existing dento-skeletal deformity. Looking at it another way, it can be said that the

Canine guidance, which allows healthy laterality for the teeth and TMJ, is more important than the relationship of upper and lower molars, as can be seen in figures 16a and 16c. In case of absence of canines, other tooth may assume its position (example: first premolars), but its function cannot be null. The first molar, upper or lower, may also be missing, but the second molar must take its position. Regardless of whether a premolar or second molar assumes the positions of canine and first molar, respectively. The changes do not alter the concept of harmony in Angle Class I occlusion. The concept of group function of the posterior teeth appeared for patients with complete muco-supported dentures. As the modern Dentistry is in the era of Implantology, when rehabilitating a completely toothless patient with a prosthesis on an adequate number of implants, laterality with canine guidance is to be used. The ideal parameter is a fixed total prosthesis on implants, a protocol prosthesis, and not muco-supported prostheses that have partial stability in the presence of an inadequate remaining alveolar ridge.

The resulting malocclusion can be either Angle Class I, II, or III, depending on the result of the joint treatment which will set the final mandible position after CDS and articular fossa surgically re-structured.

occlusal relationship found is not functional and this patient truly has an Angle Class I malocclusion[1] requiring not only orthodontic treatment and/or occlusal rehabilitation, but also an arthroplastic procedure, maxillary and/or mandible osteotomies for correcting the underlying dentoskeletal deformity. This explanation is clearly displayed on the case presented below.

Clinical case 1: Patient KCGF, female, 23 years old, presented to the private office of the author for consult, complaining of intense pain (level 10 on the visual analogue scale - VAS, where 0 = absence of pain and 10 = the greatest pain ever experienced by the patient) in the TMJs and level 8, in the cervicofacial muscles, bilaterally. She was completely unable to open her mouth due to muscular trismus, unable to work in her job, complaining of intense cephalalgia, migraines, and otalgia. The patient had undergone orthodontic treatment in several year in the past and despite clinically presenting a (pseudo) Class I occlusion of canines and molars (Figure 3a-3c), which could misguide the professional diagnosis, she had strong occlusal interferences in the posterior and anterior teeth when using lateral and protrusive guides. She was suffering from this disorder for approximately eighteen months.

Figure 3a: *Frontal intraoral photograph of a patient with intense TMJ pain. Note deviation of the dental midline, despite Class I occlusion.*

Figure 3b: *Intraoral photograph on the right side, of the same patient. Note the 'pseudo' Class I canines and molars.*

Figure 3c: *Left side intraoral photograph of the same patient. Note the 'pseudo' Class I canines and molars.*

Figure 3

MRI was ordered after two weeks of initial treatment and it showed osteoarthrosis of the right TMJ with complete anterior disc displacement, Wilkes classification grade II [91], osteoarthrosis in the left TMJ with anteromedial disc displacement associated with its deformation, Wilkes classification grade III [91] (Figure 4a-4c).

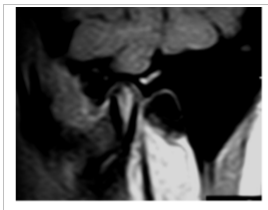

Figure 4a: *Image obtained by MRI T1, sagittal plane of the left TMJ of the same patient, showing total anterior disc displacement and intra-articular effusion in the superior space.*

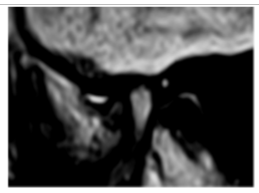

Figure 4b: *Image obtained by MRI T2, sagittal plane of the right TMJ, same patient. It is possible to appreciate the anterior band of the articular disc, which is anteriorly displaced, in addition to its deformation.*

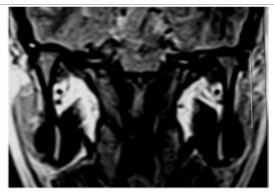

Figure 4c: *Image obtained by MRI T1, coronal plane of the TMJs, same patient, where the medial displacement of the entire posterior band of the articular disc of the left TMJ is visible.*

Figure 4

The complete treatment for her consisted of two parts, initial and definitive. The initial treatment was focused on treating the patient to take her out of the acute TMJ and cervicofacial myofascial pain which comprised of two phases. First phase, during a period of two weeks, clinical treatment with TENS/FES (Transcutaneous Electrical Nerve Stimulation/Functional Electrical Stimulation) was carried out to relieve painful (trigger/tender) points of the cervicofacial muscles (Figure 5a-5d). Supportive oral medication with non-steroidal and steroidal anti-inflammatory drugs were prescribed, as well as a nonsteroidal anti-inflammatory gel for arthritis to be externally applied over the TMJ region, bilaterally.

Figure 5a: *Demarcation of the trigger/tender points of the patient's right cervicofacial muscles.*

Figure 5b: *Demarcation of trigger/tender points on the patient's left cervicofacial muscles.*

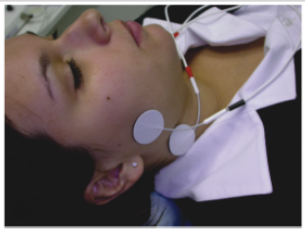

Figure 5c: *Placement of electrodes on the previously demarcated points and performance of TENS/FES on the right hemiface and neck.*

Figure 5d: *Placement of electrodes on the previously demarcated points and performance of TENS/FES on the left hemiface.*

Figure 5

In the second phase, a hard occlusal device (splint) was made in the office, at chair side, with autopolymerizing resin, and instantly installed for TMJ pain relief. The splint would prevent condyle compression of the richly innervated bilaminar zone, as well as to help diagnosing hidden dentoskeletal deformity, translated as maxilla and mandible size discrepancies. This device was used by her for just two weeks associated with continued supportive titrated pharmacotherapy. The bite/occlusion lift was determined from the posterior teeth, and it was only 2 mm. The in-office fabricated device was later readapted to include all lower teeth and slightly adapted to the maxillary teeth additionally. Mandibular displacement of any type, such as anterior repositioning, was not intended with the splint. The concept and rationale of this treatment phases were only to provide a pressure relief on the soft tissue inside the TMJ, bilaterally (Figure 6a-6c), and/or to reduce the amount and intensity of muscle activity, and/or shift elsewhere the condylar loading area.

Figure 6a: *Frontal intraoral image of the interocclusal device, readapted, installed to relieve TMJ pain and diagnose dentofacial deformity. Raise the bite on the posterior dental elements by 2 mm.*

Figure 6b: *Intraoral image on the right side with the device in use. The device did not create any intentional projection or retroposition of the mandible.*

Figure 6c: *Intraoral image left side of the interocclusal device.*

Figure 6

After a period of four weeks, the patient was completely muscle and joints pain-free, cephalalgias had subsided and her work resumed. A normal MIO measured just above 42 mm. But now her mandibular positioning was completely different from that one observed in the first consultation (Figure 7a-7c), which simulated a false Angle Class I dental occlusion. That is the reason why the first occlusion was named as a pseudo or true negative Angle Class I.

Her effective or definitive treatment also consisted of two phases. First phase - with the correlation between patient's malocclusion and her lateral cephalogram x-ray tracings established, she was referred to an orthodontist to start treatment with the specific orientation. Second phase - after orthodontic treatment to level and align teeth, surgical corrections of the TMJ and mandible were proposed, based on the predictive orthodontic (OTO = orthodontic treatment objectives) and surgical tracings (STO = surgical treatment objectives) seen on figure 8a-8c.

Figure 7a: *Frontal intraoral image of the resulting malocclusion. Note the important deviation to the right of the mandible.*

Figure 7b: *Intraoral image of the occlusion on the right side of the same patient, revealing the resulting dentoalveolar deformity. Class III occlusion of canines with Class I relationship of molars.*

Figure 7c: *Intraoral image of the occlusion on the patient's left side. Class III occlusion of canines and molars.*

Figure 7

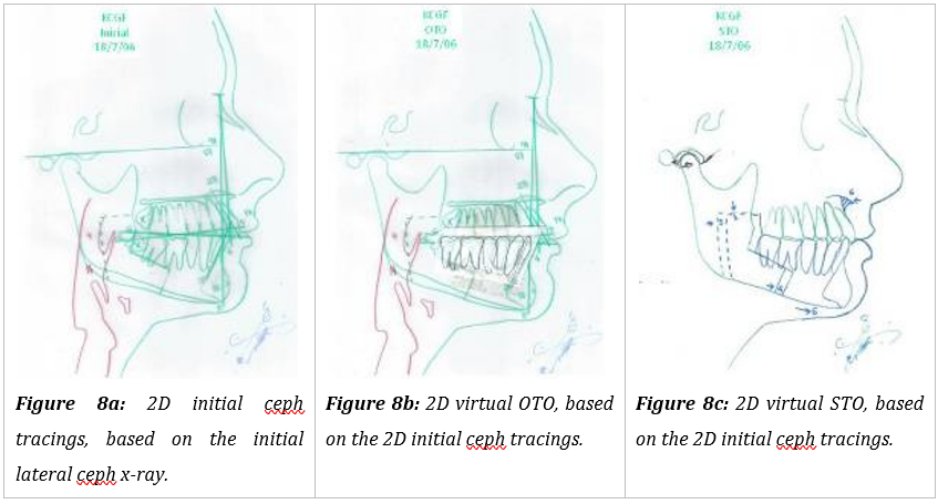

Figure 8a: *2D initial ceph tracings, based on the initial lateral ceph x-ray.*

Figure 8b: *2D virtual OTO, based on the 2D initial ceph tracings.*

Figure 8c: *2D virtual STO, based on the 2D initial ceph tracings.*

Figure 8

Therefore, four weeks after the start of this patient's clinical treatment, there was no longer any indication for occlusal device (spint) wear. However, this patient could in no way, ever, be allowed to return to her normal life as if she had already been treated for TMJ dysfunction and cervicofacial myofascial pain by splint therapy, as advocate by numerous TMJ specialists.

It is interesting to note that during anamnesis, this patient mentioned that from one day to the next she experienced intense pain, despite always having mild to moderate pain in the TMJ regions which was continually treated with analgesic/anti-inflammatory self-medication. She mentioned that she didn't know exactly what she had done wrong to cause such acute pain. This statement made by the patient may go unnoticed by a less experienced professional, but in fact, that undoubtedly reveals she suffers from chronic TMJ disease, which peaked at a certain point in her life and coincided with the search for professional help. The accompanied cervicofacial myofascial pain was just a result of the TMJ condition.

When the initial pain began, she never made the decision to seek a correct diagnosis from a dental surgeon and the appropriate guidance, despite interestingly having been treated orthodontically in the past.

The sudden appearance of a limitation in mouth opening does not mean that it is the beginning of a joint disease, but rather that the limit of tolerance, both muscular and joint, has been reached. It may even be an acute condition, but it certainly comes from a previously undiagnosed chronic condition. This was well proven and reported in 2004 [92], in a study with twenty-six patients with discs adhered to the articular eminence with persistent difficulty in mouth opening that began abruptly. Obviously, these patients did not have disc adhesion overnight. This occurred through a slow and progressive process of internal degeneration.

Within this new proposed philosophy, what would be the point of finding a patient with a MIH, maximum possible dental contacts, absence of occlusal interferences, Angle Class I occlusion, if the articular disc(s) is(were) out of its(their) anatomophysiological position, and the patient, after a few years, start reporting constant joint and myofascial pain?

In this case, disc repositioning using Mitek® Anchor technique, as described in 2001 [93], is mandatory. With the patient undergoing TMJ surgery for disc repositioning and posterior ligament repair, this occlusion will change immediately after arthroplasty,

from whatever the present occlusion is to a malocclusion with bilateral posterior open bite and a probable end-to-end anterior bite, due to the anteroinferior movement aspect of the entire mandible, guided by condylar repositioning.

Therefore, as a diagnosis for this specific hypothetical case mentioned, the patient must be diagnosed as having a Class I or II malocclusion (after neurostimulation deprogramming or occlusal splint), TMJ osteoarthrosis (the degree may vary, accordingly with the MRI findings), and associated dentoskeletal deformity. As a diagnosis to justify the indication of mandibular sagittal split osteotomy, it is possible to mention anteroposterior (AP) mandibular hyperplasia resulting from TMJ arthroplasty. Now, if the maxilla is the structure to be operated instead of the mandible, then the diagnosis would be AP maxillary hypoplasia. These diagnoses are more than enough to confirm the indication of the following procedures: a) bilateral TMJ arthroplasty for disc repositioning with Mitek® Anchor and posterior ligament repair, and b) bilateral sagittal split osteotomy of mandible for prognathism, or Le Fort I osteotomy for maxillary hypoplasia. This mandibular or maxillary deformities will only be revealed with the restructuring of the TMJ, showing the true AP length of the mandible or maxilla. Both malocclusion and mandibular or maxillary deformity might be subclinical and were masked by the TMJ disease, or rather, at the expense of TMJ deterioration.

For cases where there is a dentoskeletal deformity prior to orthodontic treatment associated with TMJ disease, both deviations can be surgically corrected. With teeth correct positioned in the alveolar bone, carried out by orthodontic treatment, the discs are surgically repositioned to their anatomo-physiological position, increasing the pre-existing deformity that will be corrected by an orthognathic surgery. At the end of the treatment, a coincident FR or FP and FO will be found which is the objective of this new philosophy.

Obviously, clinical, and radiographic diagnosis cannot be dissociated from initial and predictive facial tracings when involving orthognathic surgical procedures, as highlighted in 2010 [94,95]. The assessment of the patient's face is comprehensive and follows this sequence: a) occlusion, b) relationships of basal bone proportions via cephalometric tracings, and c) TMJs. Even if the surgery planning is 3-dimensional (3D) via VSP (Virtual Surgical Planning), the 2-dimensional manual tracings can never be dispensed with, as they are the ones that guide what will be carried out in the 3D virtual planning.

This paradigm shift is in no way a mechanistic vision for the treatment of TMJ disorders, on the contrary, it is scientific, based on evidence, validated by numerous clinical experiences and publications in the systematic literature, by measurements and evidence obtained through extensive experience of this author.

Diagnoses and surgical treatment

Likewise, when there is a patient with FR or FP, but without FO, a malocclusion is automatically diagnosed, and the treatment will be to reestablish the harmony of the dental occlusion.

Clinical case 2: Patient CAR, female, 30 years old, came to the office for consult complaining about her dental and facial aesthetics, but without pain or clicking in the TMJs. The patient was undergoing exclusively orthodontic treatment to correct bone asymmetry, through asymmetric extractions extra-arches of premolars due to a misdiagnosis by the orthodontist. The patient decided to continue her treatment with another orthodontist who was instructed to redo the orthodontic planning so that the patient could be prepared for subsequent surgical correction of the maxilla and mandible, avoiding other teeth extractions. Clinically, her face presented a mandibular and mental hypoplasia, increased stomion, lip incompetence, vertical excess of the maxilla, gummy smile, and exposure of the upper incisors beyond ideal (Figure 9a-9d). Oroscopy revealed bilateral Angle Class II malocclusion (Figure 10a-10d).

Radiographic examinations showed vertical excess of maxilla and mandibular hypoplasia and vertical anterior mandible hyperplasia, associated with AP deficiency of the chin (Figure 11a-11c). MRI imaging exams showed correct bilateral disc positioning which means FR or FP, without disc deformation, preserved joint spaces with no signs of effusion (Figure 12a-12d).

Figure 9a: *Frontal image of the face showing greater exposure of the upper incisors and enlarged stomion.*

Figure 9b: *Frontal image of the face with a smile showing exaggerated gingival exposure (gummy smile), due to the vertical excess of the maxilla.*

Figure 9c: *Right profile image of the face showing vertical excess of the maxilla and enlarged stomion, AP hypoplasia of the mandible and chin.*

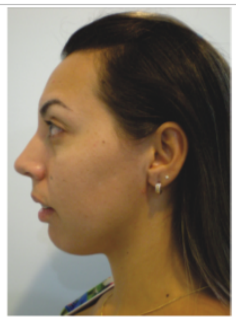

Figure 9d: *Left profile image of the face showing the same characteristics as the contralateral side.*

Figure 10a: *Frontal image of occlusion with slight deviation of the dental midlines and anterior open bite due to the exclusive occlusion of the posterior teeth bilaterally.*

Figure 10b: *Inferior frontal image of the occlusion with marked anteroposterior discrepancy and deviation of the midlines.*

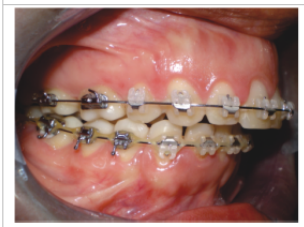

Figure 10c: *Right side image of the occlusion showing Class II malocclusion and tendency to anterior open bite. Note asymmetric extractions of premolars from previous orthodontic treatment.*

Figure 10d: *Image of the left side of the occlusion showing the same characteristics as the contralateral side. The edentulous space caused by the mistaken extraction of the left first premolar tooth was being opened for the installation of a dental implant.*

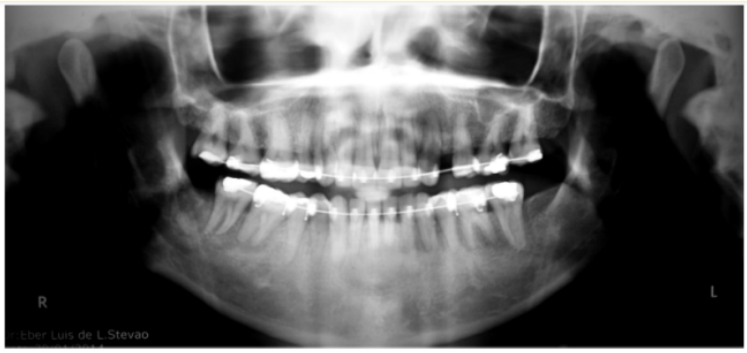

Figure 11a: *Panoramic radiograph showing the vertical amplitude of the anterior region of the mandible.*

Figure 11b: *Profile image of the face showing vertical excess of the maxilla, clockwise rotation of the maxillomandibular complex, mandibular hypoplasia associated with anterior vertical hyperplasia of the mandible and anteroposterior hypoplasia of the chin.*

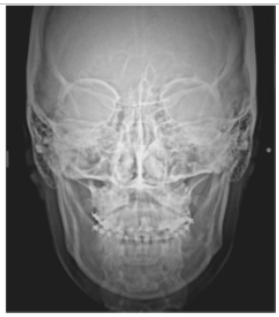

Figure 11c: *Posteroanterior (PA) image of the face showing hypertrophy of the inferior nasal turbinates and lack of coincidence of the dental midlines.*

Figure 12a: *Right TMJ MR image, mouth closed, showing the articular disc correctly positioned, slightly thinner than the contralateral side, preserved spaces without signs of effusion, muscles, and fat planes without changes.*

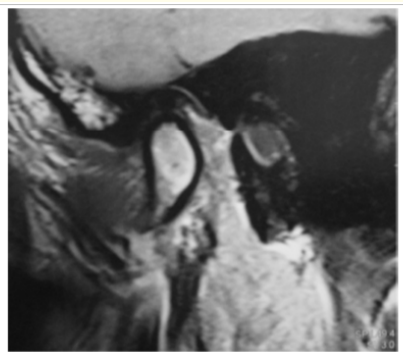

Figure 12b: *MR image, left TMJ, mouth closed, showing the correct positioning of the articular disc with normal morphology and signs, without signs of intra-articular effusion.*

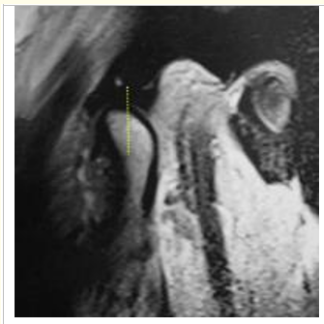

Figure 12c: *Right TMJ MRI image, open mouth, showing the disc in correct position and adequate morphology. The right condyle and articular disc are positioned slightly anteriorly, as demarcated by the vertical yellow line, when compared to the contralateral side. Presence of artifact from the orthodontic appliance.*

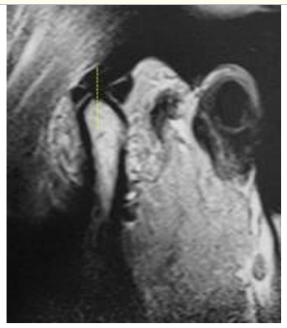

Figure 12d: *Left TMJ MRI image, open mouth, showing correct disc positioning, as well as presenting morphology within the normal range. Presence of artifact from the orthodontic appliance.*

The treatment consisted of two phases, according to the initial tracings, OTO and STO appreciated on figure 13a-13c. The first orthodontic phase followed the OTO, with simple orthodontic alignment and leveling. After the orthodontic treatment was completed, the 3D virtual surgery was planned based on the 2D tracings (Figure 14). The second phase followed the STO, with Le Fort I maxillary osteotomy and its superior repositioning, bilateral sagittal split osteotomy for mandible advancement, partial nasal septoplasty, anterior nasal spine-plasty, bilateral inferior turbinectomy, and genioplasty for advancement and vertical reduction.

The facial images of the 2-year, 4-month and 27-day postoperative control are shown on figure 15a-15d. Intraoral images of the postoperative control at 2 years, 4 months and 27 days are shown on figure 16a-16e. MRI images of full 2-month post-operative control are shown on figure 17a-17c.

Figure 13a: *Initial 2D tracing, based on the initial profile cephalogram.*

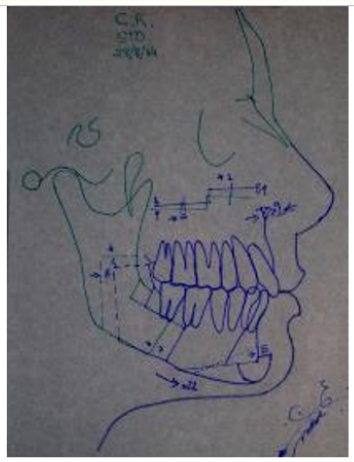

Figure 13b: *2D predictive tracing - STO (Surgical Tracing Objective), based on the initial 2D tracing.*

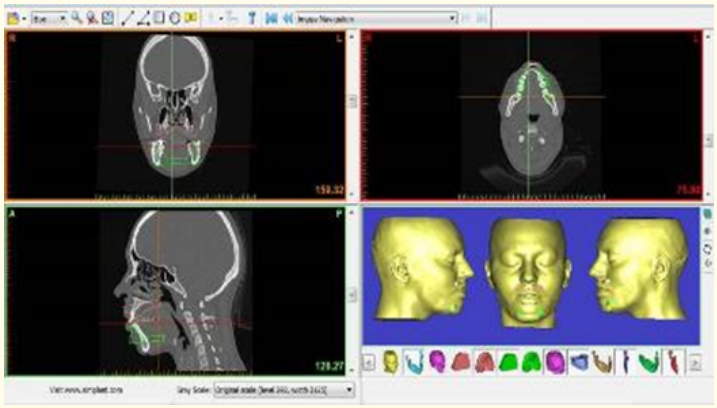

Figure 14: Virtual Surgical Planning visualized on SimPlant Pro View Platform Version 18.5. Upper left image shows coronal plane of the 3D planning. Upper right image shows axial plane of the 3D planning. Bottom left image shows sagittal plane of the 3D planning. Inferior right shows facial soft tissue and below all cuts performed to plan orthognathic surgery on this patient involving maxilla, mandible and chin.

Figure 15a: *Full face frontal view, 2 years 4 months 27 days postoperative image showing adequate balance of facial thirds.*

Figure 15b: *Full face frontal view in smile, 2 years 4 months 27 days postoperative image showing adequate symmetry and soft tissues harmony.*

Figure 15c: *Right face profile view of 2 years 4 months 27 days postoperative follow-up. Image showing adequate balance of facial thirds.*

Figure 15d: *Left face profile view of 2 years 4 months 27 days postoperative follow-up. Image showing adequate balance of facial thirds.*

Figure 16a: *Intraoral view of occlusion, right side, of 2 years 4 months and 27 days postoperative follow-up, showing excellent Class I Angle of canines and Class II of molars due to asymmetric inter-arch upper first pre-molar extraction.*

Figure 16b: *Intraoral view occlusion, frontal view, of 2 years 4 months and 27 days postoperative follow-up, showing excellent teeth intercuspation.*

Figure 16c: *Intraoral occlusion view, left side, of 2 years 4 months and 27 days postoperative follow-up, showing excellent Class I Angle of canines and molars due to symmetric inter-arch of first pre-molars extractions.*

Figure 16d: *Caudal-cephalic view of maxillary arch of 2 years 4 months and 27 days postoperative follow-up, showing an adequate format but slightly shortened arch due to pre-molars extractions.*

Figure 16e: *Cephalic-caudal view of mandibular arch of 2 years 4 months and 27 days postoperative follow-up, showing an adequate format but slightly shortened arch due to pre-molars extractions. Still present lingual fixed retainer is appreciated from canine to canine adding long term stability.*

Figure 17a: *MRI sagittal plane image of right TMJ, mouth closed, 2 months postoperatively, showing the articular disc correctly positioned, spaces preserved without signs of effusion, muscles, and fat planes without changes.*

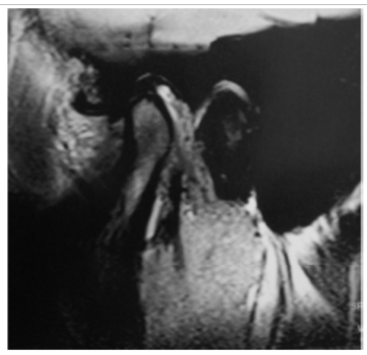

Figure 17b: *MR sagittal plane image of left TMJ, mouth closed, 2 months postoperatively, showing the correct positioning of the articular disc with normal morphology and signs, without signs of intra-articular effusion.*

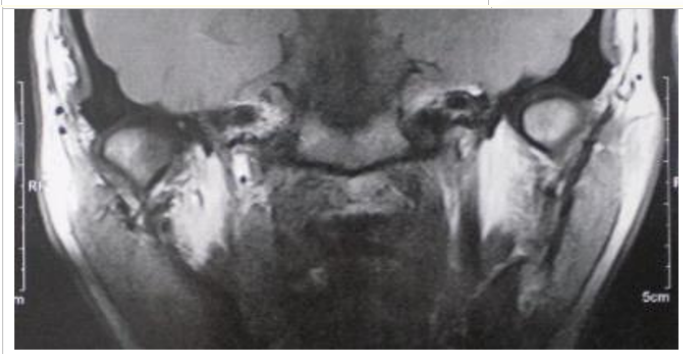

Figure 17c: *MRI coronal plane of right TMJ, closed mouth, 2 months postoperative follow-up, showing the discs in satisfactorily positioned on the top of the condyles, no signs of effusion, with muscles and adipose planes without alterations.*

Discussion

Centric Relation (CR) is nothing more than a bone-to-bone relation or a relation between the maxilla and the mandible when the condyles are in the rear upper most mid most in the articular fossa. The teeth occlusion which comes out of that relationship is called Centric Occlusion (CO). The occlusion with the highest number of teeth contacts or intercuspidation is called Maximum Intercuspal Habitual (MIH).

These are very simplest descriptions of how mandibular teeth will contact maxillary teeth. But maxilla and mandible are completely independent bones with different ratio of growth. Maxilla is a bone fixed to several other middle face structures, so it is a static structure. Mandible, on its turn, is a mobile bone, limited by an articulating structure called Temporomandibular Joint (TMJ), which is moved by masticatory musculature (MM).

The only question a curious investigator must ask is this, is CR repeatable and reproducible?

If yes, how to deal with asymmetric growth between maxilla and mandible which will never allow a MIH when the condyle must be obliged in CR? Considering an AP hypoplastic mandible, during mastication or occlusion, the MM push the condyle out of its articular fossa center, if teeth are to be effective during mastication. The articular disc, due the intense work of the lateral pterygoid muscle, will be forced to stay anteriorly to the condyle. The condyle directly compresses the bilaminar tissue (zone) which is innervated by the auriculotemporal nerve, a tributary sensory branch of the mandibular nerve, causing intense TMJ pain and irradiated be hurt along the third branch of the Trigeminal nerve. With the time passing by the dislocation of the disc becomes permanently anterior and the progression of the TMJ osteoarthritis sets its path to more advanced Wilkes stages.

But still, for an occlusion to present in a such asymmetry a dual bite has to be present and that is why these patients develop local and regional myofascial pain with trigger points distributed all over the MM.

Now, an AP hyperplastic mandible, independently how hard the MM works, during the occlusion the condyle will be seated completely inside the most upper and posterior aspect of the articular fossa. In this relationship a possible posterior disc dislocation can be found, as described in 2007 [96]. The articular disc being compressed in the most posteroinferior aspect of the articular fossa, underneath the condyle, will also provoke intense pain, causing effusion inside the joint, setting the pathway for TMJ osteoarthrosis and its progression with (fibro)cartilage destruction.

But still answering the same question above, if a reproducibility is not possible, why to use those nomenclatures to reproduce a mandible movement that is not duplicable neither physiological?

None of these terms CR, CO, HO, MIH are physiological because they do not approach the TMJ disc problem; its positioning. Mandible manipulation, trying to seat the condyle inside the articular fossa as it would be possible, is an absurd with no scientific basis of any kind, but unfortunately taught and practice in Dentistry for more than a century. Nothing is beyond this clinical ingenuity and ignorance.

Based on this problem, in 2014 [1] new terms in Dentistry were created, Functional Relation (FR) or Functional Position (FP) for the condyle and Functional Occlusion (FO) for the occlusion. Both terms exist only when the disc is situated in its anatomical position as described by Katzberg., *et al.* (1986).

On Cordray's research in 2006 [42], in fact, the second mandibular position found after neuromuscular deprogramming could not even be called CR, as the researcher did not evaluate whether there was a correct alignment of the disc-condylar system because he did not correlate this position with any MRI TMJ images for any of his patients.

The result of this study [42] seems to indicate there is an adaptive state within which the stomatognathic system can maintain its integrity, especially the TMJ. How long those 57.5% of patients will maintain this functional integrity is unknown, and which of them

did or did not have other predisposing factors for developing a joint disease were also not mentioned in the research. One question was not answered, which is, was the disc-condylar system anatomically normal, for the remaining group of asymptomatic patients (42.5%), supposedly it was understood that CR and CO were coincident, despite this observation not existing in the research? But this complexity was not discussed in the research. Once again, the terms CO, SJP, CO, OH, and MIH are confusing, and disc positioning is ignored.

There is certainly a gap that Angle fails to explain in his classification of dental occlusion, which is the functionality of the stomatognathic system and the physiological condition of the TMJ in relation to Class I, II and III, but it is quite valid for the diagnosis of dental occlusion and that breach is fully filled when the concept of condylar FR or FP and FO are applied.

It is not necessary to delete the knowledge brought by Angle, but it is necessary to change the erroneous conceptions, the mistaken paradigms that came from the misunderstanding of the well-established concepts of the past. Because if the knowledge in Dentistry reaches the point of establishing as normal any type of occlusion, as long as teeth are aligned, leveled and 'intercuspated', as intended by orthodontists and prosthodontists in their treatments, then there is no northward, and true mishandlings in Dentistry will be seen. For other areas such as restorative dentistry and/or dental prostheses this is nothing new as it is observed on daily practice with dental restorations that are completely unconcerned with the patient's type of occlusion, whether it is normal or altered, whether the TMJ is healthy, diseased or will reveal a disorder in the future, and what impact that patient's iatrogenic inherited occlusion will have on the TMJ.

Both research done in 1985 [18] and 1989 [39] correlate and are vital to the dental provider. Without them, there is no functional Dentistry to contribute to the prevention of diseases that might affect the TMJ.

Based on this author experience and agreeing with a study published in 2016 [86], without doubt, face bow and articulator do not bring any valuable data for clinical evaluation of condyle-disc structure, because that cannot be evidenced clinically, and are beyond useless. Dental museums wait for those devices.

An article in 1979 [43] showed masticatory system dysfunctions when more than one bite was present. Therefore, patients should never have multiple bites nor even a dual bite.

When the variation between these two positions is small or minimal, the soft and hard tissues that make up the TMJ adequately support the local microtrauma, but when the discrepancy is large, as happens in cases of maxillomandibular bone deformities in Class II and III patients, called true deformities and not just malocclusions, tissue adaptation is almost impossible, predisposing to joint and musculoskeletal problems.

As presented on the first clinical case, several publications have placed intense emphasis solely on myofascial component of the TMJ disorders, with professionals focusing the treatment simply on muscles, having them as the culprit of the problem. That is a misconception of patient's condition because a muscle disease for these types of patients simply does not exist by itself. MM reflect the TMJ disorder causing local and/or regional trismus. If the objective would be treating injured muscle, the correct treatment would be hyperbaric oxygen therapy [97], instead of occlusal splints that in a long course certainly will cause several degrees of open bite, as well described in 2024 [98].

Occlusal stabilization splints do not stabilize anything because mandible is a mobile bone with a very specialized hinge, the TMJs, which do not follow any command whatsoever from splint therapy. Actually, these structures will be most probably permanently altered by them. Therefore, there is no scientific basis for occlusion-based treatment for TMJ internal disorder and cervicofacial myofascial pain due to the simple fact that occlusion is not static, and it moves along with the mandible.

Once for all it should be sacred in Dentistry that a patient with more than one bite has a pathognomonic sign of one or all of these: a) TMJ internal disorder, b) dentoskeletal deformities, and/or c) malocclusions. These conditions and associated symptoms should mandatorily be investigated by: 1) accurate clinical exams; 2) dental models fabricated from regular impressions or 3D intraoral scanning, sole for hand evaluation of first presented clinical occlu-

sion but never mounted; 3) extraoral x-rays including Panoramic, Lateral and PA Cephalometric; 4) other pertinent imaging such as Computed Tomography, Magnetic Resonance, and Scintigraphy or Single-photon Emission Computed Tomography (SPECT), when indicated.

Final Considerations

Definition of Centric Relation (CR), Centric Occlusion (CO), Maximum Intercuspal Habitual (MIH) have evolved over the years but no without confusion. They have become unclear and very conflicting due to lack of real understanding of the Temporomandibular Joint (TMJ) anatomy and its clinical application. These terminologies have been taught in Dental School for almost one hundred years now since Hanau introduced these names in 1926 and should be abandoned in the modern Dentistry and the new concepts Functional Relation (FR) or Functional Position (FP), and Functional Occlusion (FO), directly incorporated in the common nomenclature among general clinicians, orthodontists, prosthodontists, dental implantologists, and oral and maxillofacial surgeons.

Also, there is no need to maintain the term MIH because the best occlusion habitual which is translated in the maximum intercuspation or intercuspidation of teeth, must be coincident with the FO. Therefore, there is no dual bite for a healthy occlusal patient when in FR or FP and FO.

The specialized clinician must be competent to diagnose patients using these new concepts, and confident when treating them in FR or FP and FO.

Conflict of Interest

The author of this article declares no financial interest and that there is no conflict of interest.

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