A CLASSIFICATION SYSTEM FOR THE MANAGEMENT OF BIOMECHANICAL FACTORS IN DENTISTRY

I. INTRODUCTION

Virtually all Masticatory System structural breakdowns are a result of either microbial or biomechanical factors. Microbial factors primarily affect the teeth and periodontium and cause caries and periodontal disease. Both of these disease processes are well documented, and much attention is given to their evaluation and treatment. In contrast, biomechanical factors affect not only the periodontium and teeth (or restorations and prostheses upon the teeth) but also the masticatory muscles and TM-Joints. Because biomechanical issues impact upon each component of the Masticatory System, they affect nearly every type of dental treatment. Despite this fact, biomechanical issues in dentistry do not seem to be as well documented or understood as those caused by microbial factors. This is of particular concern because of the possibility that this will lead to inappropriate or inadequate patient treatment.

To contribute to a better understanding of biomechanical issues and their improved management, the Integrated Classification System (of Biomechanical Factors) has been developed. It does so by separating the entire spectrum of biomechanical issues into its fundamental components and then considers each in a way that guides both their evaluation and treatment. It is the purpose of this article to introduce the concept of the Integrated Classification System to all dentists, but especially those that are involved with the restorative and esthetic rehabilitation of teeth.

II. RATIONALE

A good classification system should be simple to understand, while providing insight to treatment selection. In addition, the more specific the classification system is, the more meaningful it is. The Integrated Classification System is intended to provide guidance to the evaluation, diagnosis, and treatment of biomechanical issues for dentists in a manner that fulfills these requirements. The following statements are the guiding principles of design of the Integrated Classification System:

I. Biomechanical factors play a significant role in the predictable success of restorative and esthetic dental treatment, as well as the comfort and quality of life of our patients.

II. Biomechanical factors are most effectively evaluated if separated into their three primary components:
    1. TM-Joint Stability
    2. Functional Occlusion
    3. Parafunctional Activity

III. Disorders resulting from biomechanical factors are most effectively treated if all three components are evaluated and treated, first individually in the order presented in statement II above, then in relation to each other component.

The most important quality of the Integrated Classification System is that it requires consideration of all three biomechanical components during patient evaluation. Considering all components assures not only a comprehensive biomechanical assessment, but also a highly specific classification and diagnosis. A specific diagnosis makes possible the most appropriate and focused treatment. Although designed from a restorative dentist's perspective, because of its wide-ranging biomechanical considerations and applications, it is useful for

all dentists and dental specialists. It was inspired largely by Dr. Peter Dawson's Classification of Occlusion, which considers both Occlusal and TM-Joint factors, and also by Dr. John Kois's Classification of Occlusion, which considers both functional and parafunctional occlusal factors [1,2].

III. DESCRIPTION

The Integrated Classification System is divided into three parts. Each one classifies the status of a primary biomechanical component. Each component is classified in a way that is most meaningful for Restorative Dentists. Although not detailed in this article, it is important to understand that evaluative processes used to determine the classification of each component do exist and can be learned by any dentist choosing to do so. The following are descriptions of each component of "The Integrated Classification System" (see insert).

TM-Joint Stability Classification

The Integrated Classification System classifies TM-Joint Status based on the orthopedic stability of the joint(s), as it is this quality that best predicts the effect of the joint(s) on treatment provided by Restorative Dentists. Orthopedic stability of a joint considers not only anatomic alterations of structures within the joint, but also the structure, physiology, and pathology of all other components of the musculoskeletal system associated with that joint[3]. These include supporting ligaments, muscles, and other joints. The Integrated Classification System considers all orthopedic factors because the status of joint anatomy alone is not always predictive of the joint's long-term stability or its effect on other Masticatory System structures. For example, a TM-Joint that is anatomically damaged with complete disc displacement without reduction (Piper Stage IV B) may be actively breaking down and placing the teeth and joint at considerable biomechanical risk. However, another damaged joint with a non-reducing completely displaced disc may be one that is well adapted and placing the teeth and joint at very little risk.

Analysis of TM-Joint orthopedic stability should be based on the fact that it is a synovial joint of the human body. Therefore, it should be evaluated and managed similar to other synovial joints. A fundamental orthopedic characteristic of synovial joints is that their stability involves both structural and mechanical qualities[4].

Structural stability is a pure joint anatomy or morphology consideration, referring to volumetric or dimensional stability of joint structures – e.g. is the condyle breaking down or getting smaller with time. Breakdown of joint structures results in a positional shift of the entire mandible that directly affects maxillomandibular relationships[5]. This most frequently results in a hyper-occlusion of the posterior teeth on the side of structural breakdown. Another effect of joint structure breakdown is on the mechanical stability of the joint.

In contrast to structural stability, mechanical stability is a result of the anatomy *and* physiology of the joint and also the anatomy and physiology of structures associated with the joint. It considers the effectiveness of reciprocating joint surfaces, supporting capsule and ligaments, and muscles to allow smooth, yet controlled and limited joint movement[6,7]. Structural breakdown of the condyle results in an incongruity of joint surfaces that contributes to a redistribution of stresses on the joint as well as altered mechanical stability[7,8]. However, the resultant mechanical stability of a damaged TM-Joint is also affected by the status of supporting masticatory muscles, ligaments, the other TM-Joint, and the teeth. Reduced mechanical stability leads to added biomechanical demands on all Masticatory System structures. This bi-directional cause and effect relationship between structural and mechanical elements may lead to additional breakdown of the joints as well as added stresses on the masticatory muscles and teeth (or restorations and prostheses supported by the teeth).

Each TM-Joint is classified as Stable, Manageably Adapted, Transitioning, or Unstable. Patients are classified and managed according to their more problematic joint.

DESCRIPTION OF **TM-JOINT STABILITY TYPES** :

STABLE - TM-Joint is healthy. It is structurally and mechanically *stable*. The condyle-disc assembly is intact and no degenerative processes have thus far affected the joint. Care should be taken to not create biomechanical stresses that might change this status.

MANAGEABLY ADAPTED - TM-Joint is damaged and has undergone favorable adaptation. It has *manageable* levels of mechanical and structural stability. Future structural changes are anticipated, however at a rate and magnitude that will allow management of Functional Occlusion and Parafunctional Activity. Maintenance of an acceptable biomechanical stress level is dependant upon continuous monitoring and management of the Functional Occlusion and Parafunctional Activity.

TRANSITIONING - TM-Joint is damaged and has not yet adapted. It is *structurally* unstable and experiencing a rate and/or magnitude of structural breakdown that makes management of the Functional Occlusion or Parafunctional Activity impossible. Management of patients with transitioning joints is directed toward stimulating a favorable adaptive response of the TM-Joints into a Manageably Adapted status.

UNSTABLE - TM-Joint is damaged and has adapted poorly. It is *mechanically* unstable, and is not expected to become Manageably Adapted. Orthopedic rehabilitation may improve mechanical joint stability, however control of biomechanical issues is still unpredictable. While management of the Functional Occlusion and Parafunctional Activity may be helpful, definitive restorative or prosthetic treatment should only be done with great caution and with the patient's acceptance of risk.

Functional Occlusion Classification

The Functional Occlusion is the component of the Integrated Classification System that Restorative Dentists most directly (positively or negatively) impact. It considers the relationship of maxillary to mandibular teeth during all mandibular movements involved with mastication. These include straight closure as well as all lateral and protrusive functional movements. Collectively, these movements make up the Envelope of *Function*. In the Integrated Classification System, the Envelope of Function is defined as "*the three-dimensional space contained within the Envelope of Motion that defines mandibular movement during masticatory function*" [9]. It is the "world" in which our mandible and teeth "live" in the normal chewing cycle. Functional Occlusion disorders occur when teeth interfere with this Envelope of Function.

The Envelope of Function is best understood and managed if viewed as having two elements:

1) The *Available* Envelope of Function
2) The *Required* Envelope of Function

The *Available* Envelope of Function represents the horizontal anterior-posterior spatial relationship that *exists* between lower central and lateral incisal edges and upper central and lateral lingual surfaces, with the teeth in maximum intercuspation. It is static and a purely structural component.

The *Required* Envelope of Function represents the horizontal anterior-posterior dimension that is *needed* between these same tooth surfaces to allow a non-interfering, mechanically benign relationship between these surfaces in function.

Unlike the purely structural and static nature of the *Available* Envelope of Function, the *Required* Envelope of Function is dynamic and is affected by a number of factors including Functional Occlusion relationships. It is described as *physiologic* if no posterior teeth interfere with closure of the mandible into maximum intercuspation while the condyles are in their Physiologically Seated Condylar Position (PSCP/CR). It is *expanded* if posterior teeth do interfere with physiologic closure, causing the mandible to deviate outside its physiologic path. (Figs. 1, 2, 3) (Author's note: The research of Lundeen and Gibbs was among the first to show

actual patient plots of the envelope of motion and envelope of function ("Chewing Plots"). Although portions of Figs. 1 and 2 are adapted from their work, they are not intended to show actual patient plots from their research. Rather, they are intended to illustrate the affect of posterior tooth interferences on physiologic closure of the mandible on a theoretical patient's envelope of function.) [10]

Each patient is classified as having Benign Function, Posterior Dysfunction, or Anterior Dysfunction.

DESCRIPTION OF **FUNCTIONAL OCCLUSION TYPES**:

BENIGN FUNCTION –No functionally induced occlusal disease is present. Structural damage, pain, and dysfunction resulting from Functional Occlusion relationships are either absent or present to a degree that currently are not, and whose implications will not adversely affect patient quality of life.

POSTERIOR DYSFUNCTION – Posterior tooth relationships are interfering with a *physiologic* Envelope of Function and are causing disease. Structural damage, pain, and/or dysfunction from posterior tooth relationships currently are, or their implications may adversely affect patient quality of life. Posterior Dysfunction is divided into two types:

Type I (Simple)
Posterior tooth interferences to the Envelope of Function are not damaging the teeth or are damaging only posterior teeth.

Type II (Compound) "Pseudo Anterior Dysfunction"
Posterior tooth interferences to the Envelope of Function are damaging posterior and anterior teeth.

ANTERIOR DYSFUNCTION - Anterior tooth relationships are interfering with a *physiologic* Envelope of Function and are causing disease. Structural damage, pain, and/or dysfunction from anterior tooth relationships currently are, or their implications may adversely affect patient quality of life. Anterior Dysfunction is divided into two types:

Type I (Primary)
Anterior tooth relationships are interfering with straight closure of mandible with condyles in PSCP/CR *and* are also interfering with other movements of a *physiologic* Envelope of Function.

Type II (Secondary)
Anterior tooth relationships are *not* interfering straight closure of mandible with condyles in PSCP/CR, but *are* interfering with other movements of a *physiologic* Envelope of Function.

Parafunctional Activity Classification

The final component classifies patient Parafunctional Activity. In the Integrated Classification System, parafunctional activity is defined as all mandibular movements involved with non-physiologic movement the mandible. These include all movements *except* the normal chewing cycle, swallowing, breathing, or speech. Parafunctional Activity classification is based upon two clinical criteria. The first is whether or not the parafunctional activity is causing any damage, pain, or dysfunction to any part of the Masticatory System. The second is the etiology or etiologies of the parafunctional activity.

Each patient is classified as having Benign Parafunctional Activity, Structural Parafunctional Activity, CNS Parafunctional Activity, or Secondary Parafunctional Activity.

DESCRIPTION OF **PARAFUNCTIONAL ACTIVITY TYPES**:

BENIGN PARAFUNCTION –No disease from parafunctional activity is present. Parafunctional activity is either absent, or structural damage, pain, and dysfunction from parafunctional activity are absent or present to a degree which currently is not, and whose implications will not adversely affect patient quality of life.

STRUCTURAL PARAFUNCTION – Parafunctional activity is causing disease in the form of structural damage, pain, or dysfunction and structural elements of the Masticatory System are the primary initiators. Functional Occlusion relationships quantitatively and/or qualitatively *do* affect Structural Parafunctional Activity.

CNS PARAFUNCTION – Parafunctional activity is causing disease in the form of structural damage, pain, or dysfunction and Brain Stem activity of the Central Nervous System is the primary initiator. Functional Occlusion relationships do *not* quantitatively or qualitatively affect CNS Parafunctional Activity.

SECONDARY PARAFUNCTION - Parafunctional activity is causing disease in the form of structural damage, pain, or dysfunction and is initiated by extrinsic or intrinsic factors not included in Structural or CNS Parafunctional Activity. Functional Occlusion relationships do *not* quantitatively or qualitatively affect Structural Parafunctional Activity. Extrinsic initiators include Amphetamines, Extacy, and Selective Serotonin Reuptake Inhibitors (SSRI's). Intrinsic initiators include Basal Ganglion tumors.

IV. DISCUSSION

Collectively, the TM-Joint Stability, Functional Occlusion, and Parafunctional Activity component classifications make up the Integrated Classification System. Proper selection of biomechanical treatment is a two-step process that begins with classifying each of these three components. In the first step, after each component is classified, a "Patient Type" is assigned to the patient. Each combination of TM-Joint, Functional Occlusion, and Parafunctional Activity classifications defines a unique Patient Type. Each Patient Type has a unique set of treatment options and/or restrictions that may be appropriate for treating that patient's biomechanical issues.

The Integrated Classification System includes Patient Types and guides treatment of patients with all four TM-Joint classes. However, because this article is primarily designed for dentists involved with restorative and esthetic treatment, only treatment details for Patient Types with Stable and Manageably Adapted joints have been included. Definitive treatment and management options considered in the Integrated Classification System for patients with these joint types include:

1. Additive Reshaping
2. Reductive Reshaping
3. Orthodontic/Orthognathic Tooth Movement
4. Night Guard Appliance Management

For those dentists who choose to treat patients with Transitioning and Unstable joint classifications, treatment must begin with rehabilitation of the joints - the goal of which is to assist the joint(s) in becoming Manageably Adapted. It is not until the time that both joints become Manageably Adapted that definitive restorative or esthetic treatment should be performed.

It should be noted that even though all dentists do not need to treat patients with Transitioning or Unstable TM-Joints, it is critical that they are able to identify them and make an appropriate referral. Fortunately, the vast

majority of patients seeking restorative or esthetic treatment have either Stable or Manageably Adapted joints. It is this large group of patients who can most benefit from correction of biomechanical problems with clinical skills that all dentists treating these patients should possess.

The second step of proper biomechanical treatment selection involves identifying which one or combination of potentially acceptable options is most appropriate for a specific patient. This requires consideration of both biomechanical Patient Type *and* patient wants and needs independent of biomechanical issues. Patients' wants and needs to consider include:

1. Improved Function
2. Improved Esthetics
3. Needed Restorations
4. Elimination of Pain
5. Maintainable Dental Health

The option or combination of options that most conservatively achieves biomechanical harmony, and is also consistent with all other patient wants and needs should be utilized. With the proper selection and execution of the above listed options, there are virtually no patients with Stable or Manageably Adapted TM-Joints that cannot become biomechanically healthy.

V. UTILIZATION

Utilization of the Integrated Classification System is best understood when it is viewed as being part of another larger system. This larger system, hereafter referred to as the Physiologically Driven Treatment System (PDTS), consists of three parts: the Integrated Classification System (ICS), the DATA Appliance (Diagnosis And Treatment Assisting Appliance), and a Stable Biomechanical Platform. Details of this system were described in a previous three part series of article published in *Spectrum Dialogue*[12,12,13]. The series of articles, entitled "A Systematic Approach to Esthetic and Functional Treatment", described a clinical case in which both the functional and esthetic evaluation and treatment of a patient were guided by this system. The following is a brief review of a part of these articles that demonstrated utilization of the ICS and the PDTS. Demonstrating their utilization in a clinical case may be helpful for readers to better appreciate both their use and advantages.

A critical part of the PDTS, the DATA Appliance is a removable appliance with an anterior stop that is used to assist in both evaluating and treating biomechanical force issues. It is used to provide patient information regarding each biomechanical element of the ICS [14,15] (Fig. 4). In the case described in the previous article, initial patient evaluation of biomechanical force issues revealed generalized moderate to severe excessive tooth wear, painful masticatory muscles, and damaged TMJ's. Both joints could accept firm loading with no sign of tension or tenderness, although clicking sounds that had been present for many years were noted in the left joint. Range of motion measurements were within normal limits.

These findings were consistent with damaged, but well adapted (Manageably Adapted), TMJ's. To confirm this, a DATA Appliance was fabricated and seated. The DATA Appliance anterior stop was adjusted to allow contact of one lower incisor with closure, perpendicular to the arc of closure, allowing approximately 2mm interocclusal space between the most posterior teeth.

The patient was initially re-evaluated after wearing the DATA Appliance twenty-four hours a day for ten days (except during eating and oral home care). Three significant responses were noted:

1) There was a near complete elimination of facial pain and joint sounds.
2) There was no evidence of parafunctional activity on the DATA Appliance acrylic anterior stop.
3) The patient reported that after seven days of wearing the DATA Appliance, tooth #'s 15 and 18 were in contact if he closed with the appliance in place.

A bite registration using Futar D Occlusion bite registration material (Kettenbach GmbH & Co.; Eschenburg, Germany) with the DATA Appliance in place confirmed tooth #'s 15 and 18 were in contact. At that time, additional acrylic was added to the anterior stop to once again allow approximately 2mm posterior tooth interocclusal space.

The patient was next seen twenty-one days later. He reported a continued near complete absence of facial pain, with no joint sounds, and there was no evidence of parafunctional activity on the DATA Appliance anterior stop. Another bite registration was made and revealed tooth #'s 15 and 18 nearly in contact again. Subsequent identical bite registrations were made over the next two weeks, and stabilization of maxillomandibular relationships was confirmed. A facebow registration to record the hinge axis was made and the maxillary cast mounted. The mandibular cast was then mounted using a Futar bite registration (Figs. 5 A, B, C).

In this patient's case, information from DATA Appliance response, along with history and clinical examination findings, confirmed an ICS TM-Joint Stability diagnosis of *Manageably Adapted*. Significant history and examination findings included unchanging joint sounds, a normal ROM, and joints that could accept firm loading with no sign of tension or tenderness. These findings combined with a patient DATA Appliance response resulting in masticatory muscle pain elimination and stabilization of condylar position (as evidenced by precisely reproducible bite registrations) confirmed a Manageably Adapted TMJ status.

DATA Appliance response also confirmed a Functional Occlusion diagnosis of *Posterior Dysfunction* and an *initial* Parafunctional Activity diagnosis of *Benign* or *Structural* Parafunctional Activity. A diagnosis of Posterior dysfunction was confirmed when posterior teeth (in this case, tooth #'s 15 and 18) were found to interfere with closure of the mandible after the condyles were physiologically seated (Figs. 6 A, B). Because damage to the dentition involved both anterior and posterior teeth, a specific diagnosis of Posterior Dysfunction Type II was made. An initial diagnosis of either Structural or Benign Parafunctional Activity was made when no evidence of parafunctional activity was found on the DATA Appliance's anterior stop (Figs. 7 A, B).

This combination of TM-Joint Stability, Functional Occlusion, and Parafunctional Activity diagnoses is common and one that can predictably benefit from occlusal correction. For this ICS classification (Patient Type 3M), occlusal correction may include additive reshaping, reductive reshaping, and/or orthodontic/orthognathic treatment (see insert – Patient Type 3M). As stated in the previous section of this article, for any given patient, the proper choice of potential treatment modalities is dependent upon *all* their wants and needs – including functional, esthetic, and restorative considerations. In this patient's case, occlusal correction was most appropriately accomplished with a combination of reductive and additive reshaping. As in most cases, not only did this patient benefit from occlusal correction, but the occlusal correction was a fundamental requirement for developing a Stable Biomechanical Platform.

A Stable Biomechanical Platform is achieved when interocclusal relationships are in harmony with masticatory muscle function, together with healthy or well-adapted TMJ's, *at the final treatment vertical dimension of occlusion.* It requires that maximum intercuspation occurs with equal intensity contact of all teeth with both condyles physiologically seated. It also requires an anterior guidance that allows disclusion of the posterior teeth and one that is in harmony with the Envelope of Function. Creating this platform will not only assure patient comfort, but also serve as a foundation upon which ideal esthetic and functional design can be effectively developed and delivered.

VI. CONCLUSION

It is difficult to imagine a dentist who has not experienced the affects of failing to properly manage a patient's biomechanical issues - whether they are a cosmetic dentist, restorative dentist, prosthodontist, orthodontist, or any dentist wanting to help their patients achieve comfort and maintainable dental health. However, only after

the status of each biomechanical component of the Integrated Classification System is determined is it possible to predictably manage these issues. Failure to properly evaluate and address even one component may result in inappropriate or inadequate dental treatment. Inappropriate or inadequate treatment, in turn, often results in undesirable consequences for both the patient and dentist. Countless hours of time and dollars are wasted by dentists each year repairing or replacing restorations that have failed because of harmful biomechanical stresses. Many patients suffer daily with facial pain or tooth loss resulting from biomechanical disharmony within their Masticatory System. These common occurrences are most disturbing because in the majority of cases, they could have been avoided.

A primary objective of the Integrated Classification System is to help prevent such problems. It does so most effectively by working in conjunction with the DATA Appliance and the concept of a Stable Biomechanical Platform. Combined, they are intended to help achieve biomechanical stability by providing guidance to appropriate evaluation and treatment.

The Integrated Classification System is a tool for dentists to use to improve the quality of their dental treatment and the quality of life of their patients. This is only predictably accomplished with attention to both microbial and biomechanical issues. Regardless of their background or training, it is the goal of the Integrated Classification System to encourage and assist all dentists to improve their skills in recognizing and managing biomechanical problems.

The Integrated Classification System
Figures and Descriptions

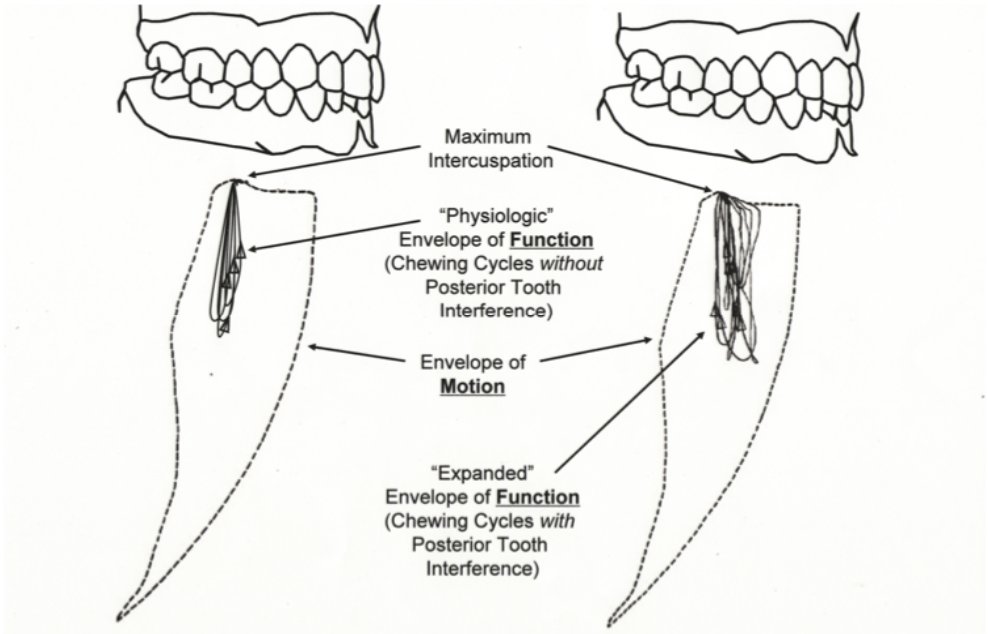

Fig. 1 Sagittal view of typical Envelope of Motion, Physiologic Envelope of Function, and Expanded Envelope of Function (Note significantly increased anterior movement of lower incisors during chewing cycle as a result of posterior tooth interference)

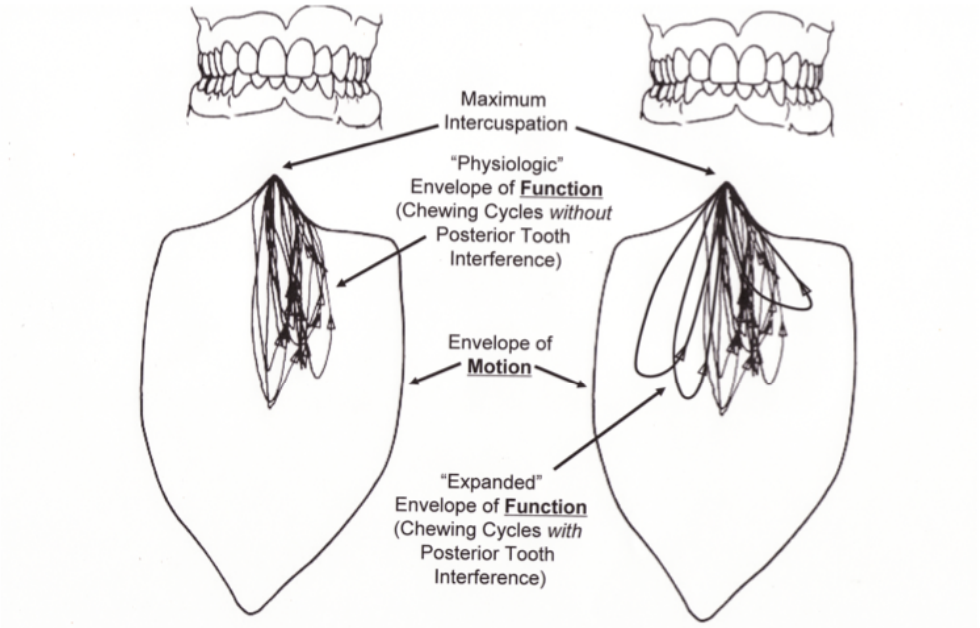

Fig. 2 Frontal view of typical Envelope of Motion, Physiologic Envelope of Function, and Expanded Envelope of Function (Note significantly increased lateral movement of lower incisors – as well as all othe lower teeth - during chewing cycle as a result of posterior tooth interference)

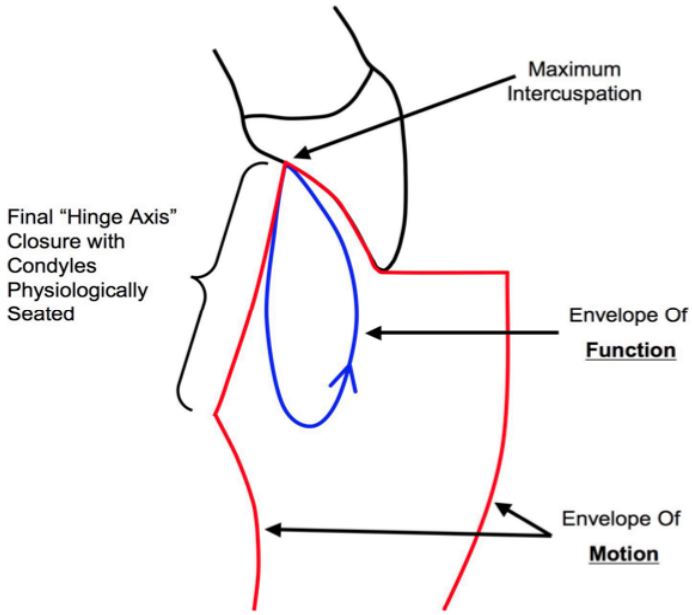

Fig. 3 Close-up sagittal view of typical Envelope of Motion and a Physiologic Envelope of Function (note: maximum intercuspation occurring in harmony with physiologically seated condyles)

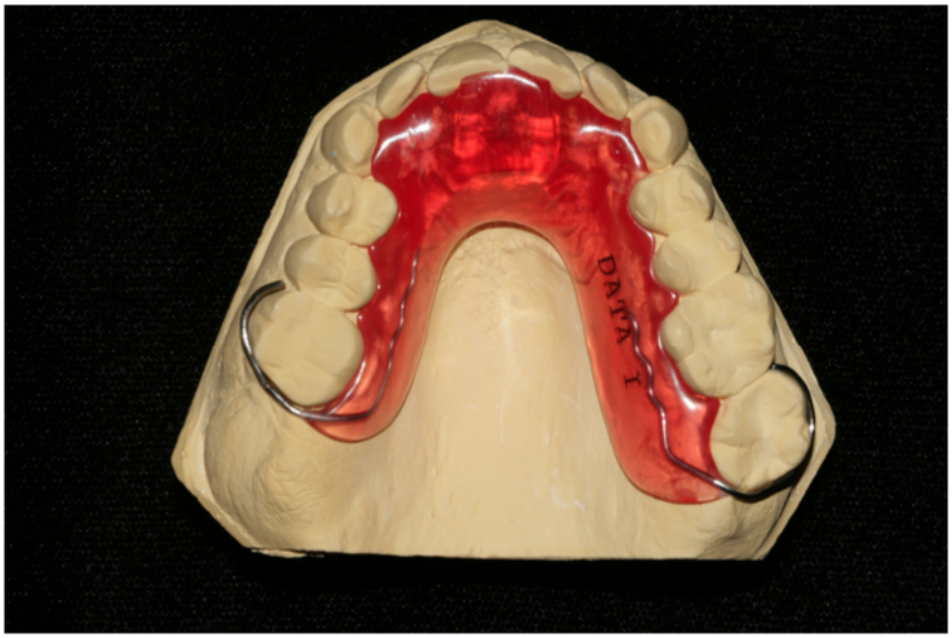

Fig. 4 A DATA Appliance

Fig. 5A

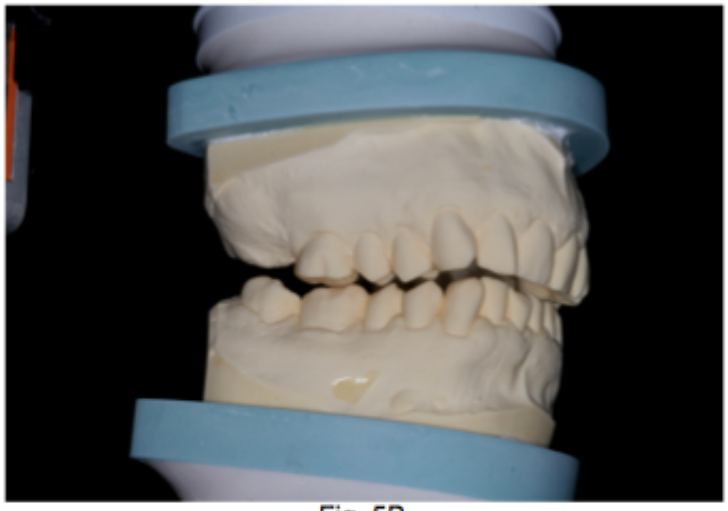

Fig. 5B

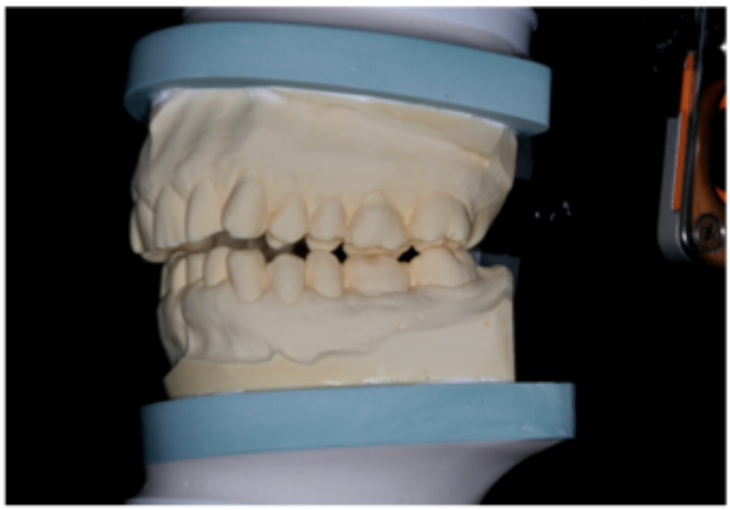

Fig. 5C

Figs. 5 A, B, C Interocclusal relationships of patient with Posterior Dysfunction with condyles physiologically seated

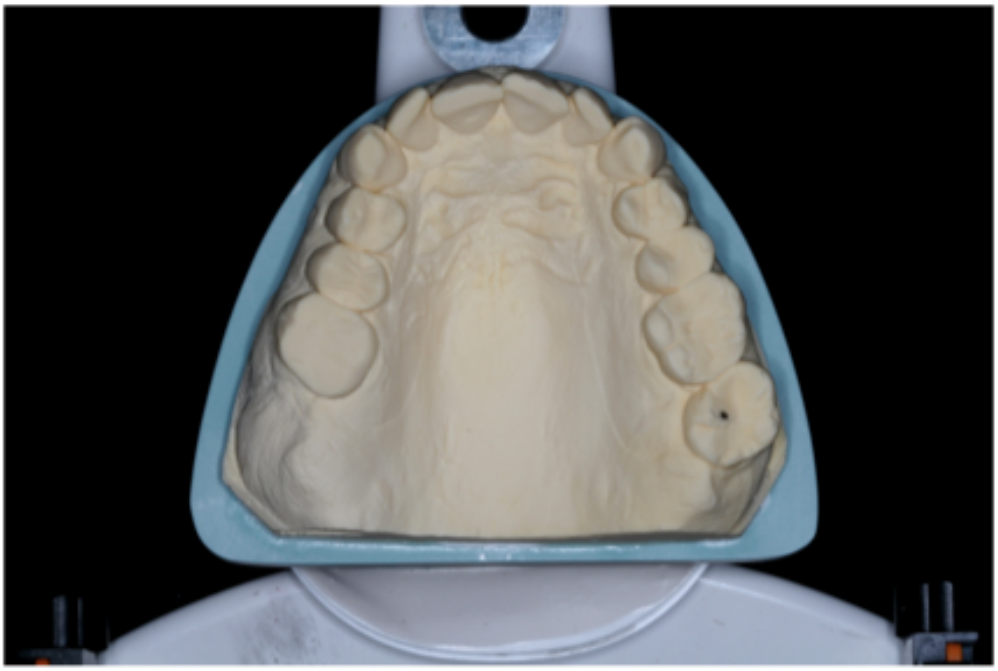

Fig. 6A

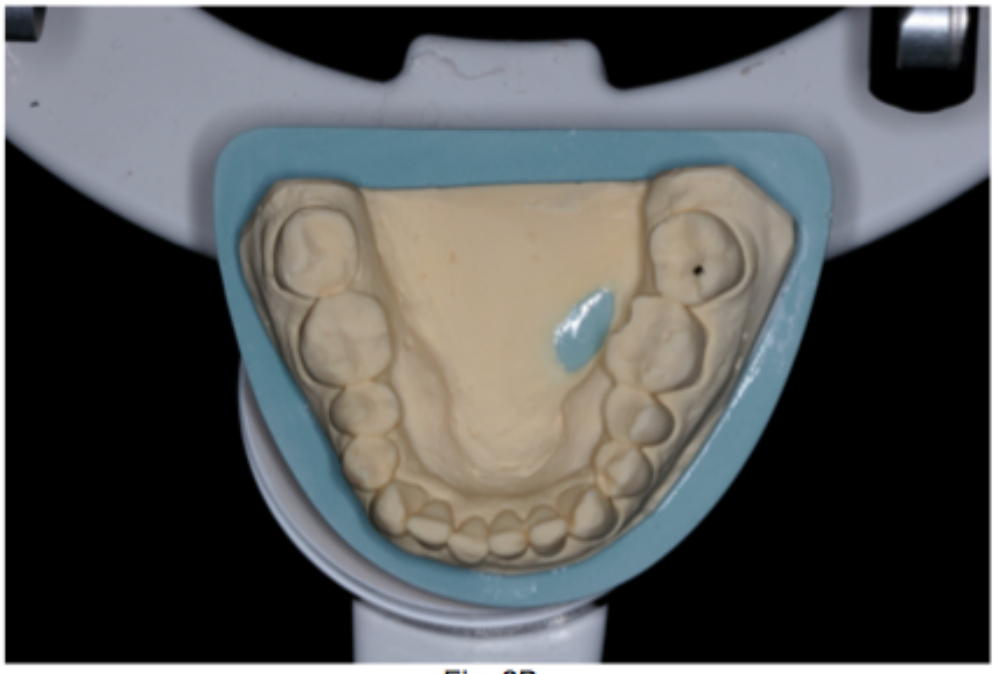

Fig. 6B

Figs. 6 A, B With condyles physiologically seated, Posterior Dysfunction is confirmed on articulator with first occlusal stop on tooth #'s 15/18

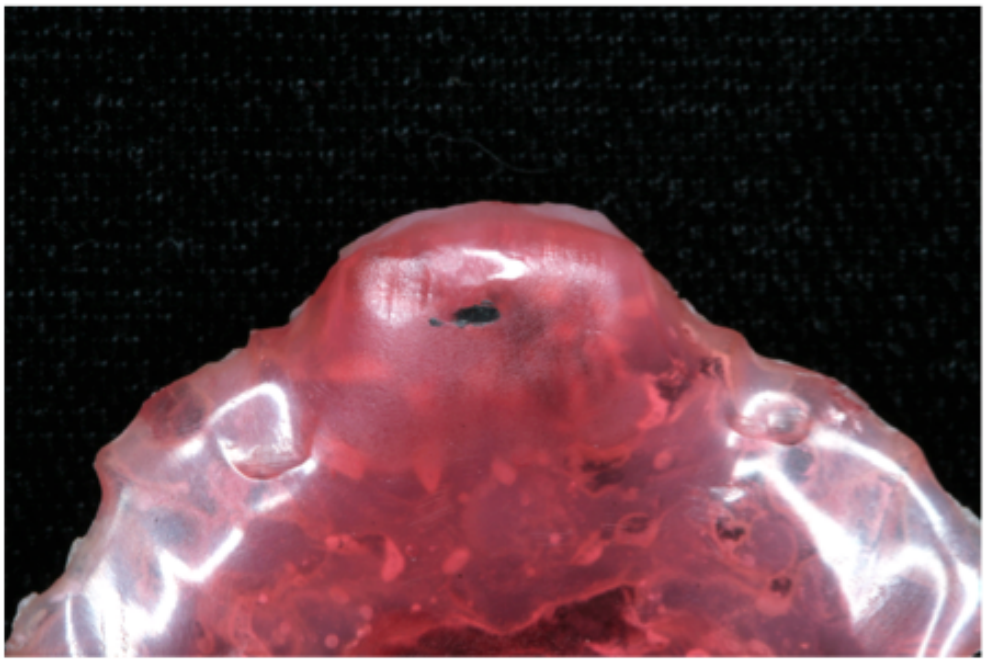

Fig. 7 A An initial diagnosis of Benign or Structural Parafunctional Activity is made when there is no evidence of parafunctional activity on the DATA Appliance anterior stop (Note: this is the article patient's DATA Appliance)

Fig. 7 B In contrast, CNS or Secondary Parafunctional Activity is diagnosed when there *is* evidence of parafunctional activity on the DATA Appliance anterior stop (Note: this is not the article patient's DATA Appliance)

Acknowledgments:
I would like to acknowledge the following individuals for their contributions to the creation of the Integrated Classification System. First are Dr. Peter Dawson and Dr. John Kois for opening the minds of dentists around the world to the true nature of biomechanical factors in dentistry. Next are Dr. Mark Piper, Dr. John Droter, and Dr. Edward Zebovitz for their relentless pursuit of a better understanding of the Temporomandibular Joint. Finally are the late Drs. Harry Lundeen and Hudson (Hud) Heidorf for their unselfish encouragement and support of my efforts to help my profession and my patients.

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