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Original article:

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**Introduction**

In recent years the dental profession has become clearly divided into two general concepts for determining the correct mandible to skull relationship at maximum intercuspation. The condylar theory, more commonly referred to as the gnathologic approach, espouses the retruded, "terminal hinge" position (centric relation) and certain manipulated border movements as the determinants of occlusion, reproducibility being the only justification. No consideration is given to the tension and stress applied to the neuromuscular elements of the stomatognathic system by this approach. The neuromuscular theory, in direct opposition, states that muscle relaxation is prerequisite to obtaining an occlusal position that will in turn sustain a relaxed musculature, and that the level of residual tension within a voluntarily inactive musculature is inversely proportional to the overall health and functional efficiency of the entire system.

New advances in science have always had to await the development and availability of appropriate instrumentation. The advance of dentistry into neuromuscular occlusion is no exception.

The Myo-monitor® (Fig. 1) was originally developed as a means of applying the neuromuscular approach to occlu-

sion. The impetuses for development were: 1. the complete lack of any evidence that function or parafunction occurs at centric relation or along border pathways, 2. a realization that the T.M.J., like any other joint, does not originate but merely accommodates movement, and 3. an acceptance of the uniqueness of a given patient and the need for a technique capable of registering that uniqueness. Thus, the Myo-monitor® technique is an intra-systemic approach to occlusal positioning using



1 The Model J-3 Myo-monitor®

the patient's own musculature and eliminating ambiguous, universal, and arbitrary criteria.

### Scope

The objectives of this article are: 1. to clarify for the reader the physical characteristics of the Myo-monitor®, 2. to review the various clinical diagnostic and treatment procedures that may be realized through its use, and 3. to reveal its susceptibility to abuse by persons untrained in its use.

### I. The mechanism

#### The neural stimuli

The Myo-monitor® is a digital, electronic pulse generator specifically optimized for bilateral transcutaneous electrical neural stimulation (TENS) of the stomatognathic system.<sup>1</sup> The mechanism through which it functions is universally known to the physiologist but has only partially captured the awareness of the dental profession.<sup>2</sup> The stimuli of the present model J-3 Myo-monitor® are 500 microseconds in duration and continuously variable in amplitude from 0 to 25 milliamps maximum. A balance control allows the operator to adjust the relative strengths of the stimuli to the right and left sides for a balanced response. The stimuli are biphasic with a cathodic (negative) initial stimulating phase followed by an anodic (positive) discharge phase and occur at a fixed rate of 40 pulses per minute.

#### Neural stimulation

The Myo-monitor® has been optimized for stimulation of the motor branches of the V<sup>th</sup> and VII<sup>th</sup> cranial nerves, bilaterally, using surface electrodes.<sup>3</sup> While some previous authors<sup>4,5</sup> reported failure in their attempts to record E.M.G. evidence of Myo-monitor®-

induced masticatory muscle contractions, except in the masseter, the more advanced E.M.G. recording techniques of Fujii and Mitani<sup>6</sup> have shown clearly the *neural mediation* of the stimuli, as have subsequent intensity-duration tests.<sup>1</sup> Thus, the muscle responding to the Myo-monitor® stimuli include all of the muscles of mastication and facial expression.

#### Reproducibility

The term "reproducible" has become a byword, especially in prosthodontics, probably because until recently no one has developed any other criterion for the mandible to skull relationship at occlusion. Consequently, a "reproducibility fixation" devoid of functional validity has developed such that the consistency of a given result is given more import than the functional correctness of that result. Basing a physiologic value judgment solely on repetitiveness is analogous to throwing darts at a blank wall and then drawing a target around them in the most advantageous manner.

How repetitive is the new instrumentation developed to enable the dentist to achieve neuromuscular occlusion? A recording of 40,000 consecutive output stimuli from a Model J-3 Myo-monitor® superimposed on an oscilloscope (Fig. 2) shows an extremely precise, repetitive pattern. A three-dimensional Mandibular Kinesiograph<sup>7</sup> recording of Myo-monitor®-induced mandibular movement (Fig. 3) shows a similarly consistent muscular response pattern *after* the musculature had relaxed under 30 minutes of Myo-monitor® pulsing. However, in Figure 4, taken of the same patient *before* the muscle was relaxed, a highly inconsistent response was recorded using the same repetitive stimuli. Thus, the operator must observe certain precautions when utilizing

Fig. 2 A recording of 40,000 consecutive output stimuli from a Model J-3 Myo-monitor® superimposed on an oscilloscope shows an extremely precise, repetitive pattern

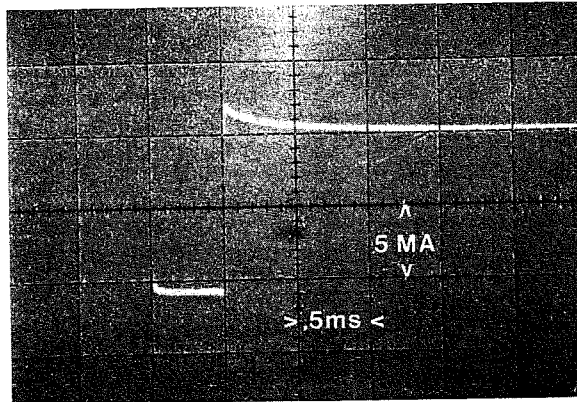


Fig. 3 After 30 minutes of Myo-monitor® relaxation. Recording of 100 consecutive pulses (2—1/2 minutes). Note stability of rest position and repetitiveness of occlusal position (termination of spike)

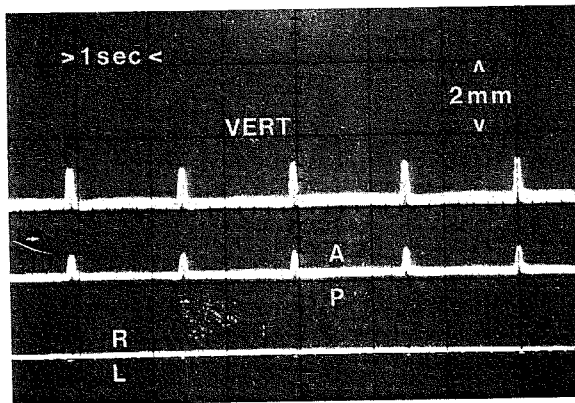
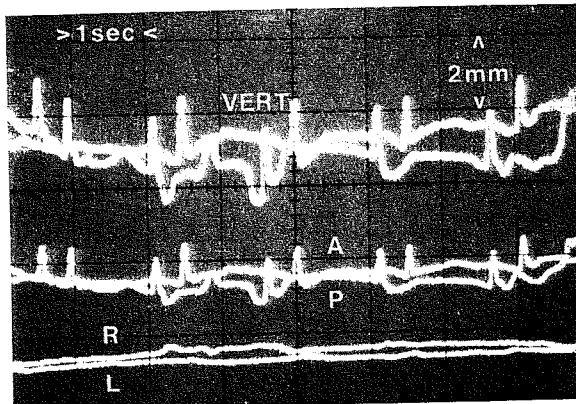


Fig. 4 Before relaxation. Unrelaxed neuromusculature response of same patient taken before recording in figure 3. Note unstable rest position and variation of occlusal position.





the Myo-monitor® for diagnosis and treatment.

## II. The uses

### Relaxation

The gentle twitch contractions of the masticatory musculature which result from Myo-monitor® threshold stimulation actively produce a more relaxed state through the same mechanism associated with normal muscle activity. Thus, fatigue spasm or myostatic contracture are eliminated by the mild, rhythmic muscle movement, and normal physical balance is restored.<sup>8</sup> This procedure, which typically requires 30 to 40 minutes and relaxes the mandibular muscles to their resting length (rest position of the mandible) *must always* be accomplished prior to any other use of the Myo-monitor®!<sup>9</sup> It requires a quiet atmosphere for the patient (no talking, gum chewing, etc.) and precludes the use of clutches or any other proprioceptive interference. The Myo-monitor® amplitude should be adjusted so that the closure terminates short of tooth contact during pulsing. After 30 minutes have elapsed, the stability of rest position should be monitored clinically or with the Mandibular Kinesiograph® to verify that relaxation has been achieved.\*

### Occlusal registration

Only after the muscles have been relaxed to their resting length can relaxed neuromuscular occlusal registration be achieved. Rest position of the mandible (RPM) then becomes the launch pad from which the mandible is carried on a relaxed trajectory through the inter-occlusal (freeway) space to terminate at the occlusal position compatible with

a relaxed musculature. *The remarkable repetitiveness of the neuromuscular registration when these requirements are meticulously followed is shown in Figure 3.*

It is important that every neuromuscular occlusal registration first be monitored under empty mouth conditions. MKG® recordings consistently show that the introduction of a foreign body into the mouth, particularly over the occlusion, produces a neuromuscular response that alters relational measurements, particularly noticeable as an increase in vertical dimension. Before introducing any registration material into the mouth, the "empty mouth" measurements should first be obtained to use as a control. The method is described in the maxillo-mandibular registration manual.<sup>10</sup>

Before any occlusal or maxillo-mandibular registration can be accurately taken, the following conditions must be met:

- The patient must be standing in a balanced, forward-looking position.
- The patient's musculature must be relaxed and an "empty mouth" verification must be made clinically of the location and stability of rest position.
- The bilateral balance of the musculature must be verified clinically while pulsing and, if necessary, adjusted with the Myo-monitor® balance control.
- The correct recording medium (occlusal indicator wax, Myo-print®, etc.) must be available to the operator, and he must have a thorough knowledge of its use.

After the necessary preliminaries are satisfied, the operator can take the registration following the precise step-by-step procedure as shown in the technique manual.<sup>10</sup> The resulting occlusal position will be on the patient's

\* E.M.G. systems can and have also been used for this purpose. However, they are more awkward and consequently less practical.

own unique, relaxed trajectory at a physiologically correct vertical rather than at an ambiguous, universal, "hinge axis" position (centric relation) devoid of functional muscle compatibility.

#### Coronoplasty and occlusal diagnosis

A very precise and straight-forward technique of removing premature contacts from an occlusion utilizing the Myo-monitor® is referred to as coronoplasty. The patient is first relaxed by pulsing for 30 to 40 minutes, then occlusal indicator wax is applied to one arch. Next, the Myo-monitor® amplitude is increased until the first point(s) of contact is marked in the wax. The initial contact point(s) [on the relaxed trajectory] is adjusted, new indicator wax is applied to the opposing arch, and the initial contact point(s) is again located. This procedure is continued until all teeth contact simultaneously (cusp tips and fossae). Coronoplasty may be contra-indicated in a given case (i. e., excessive vertical interocclusal space, greatly worn and/or deteriorated dentition, etc.). To determine precisely the nature and extent of any malrelationship, a Myo-monitor® maxillo-mandibular registration or, preferably, a Kinesiograph® analysis can be taken.

#### M.D.P. (T.M.J.) Syndrome

Occlusal diagnosis is greatly facilitated, whether for prosthetic, orthodontic, or periodontic reasons, by the use of the Myo-monitor®. A maxillo-mandibular registration taken when the musculature has been suitably relaxed constitutes a precise recording of the discrepancy between the existing occlusion and the muscle-oriented mandible to skull relationship. In the case of a T.M.J.-M.P.D. syndrome patient<sup>11-14</sup>, the electronic occlusal registration is done automatically by the patient's own

muscles under control of the Myo-monitor®. The registration can be used as an "instant splint" or converted to a processed splint (with occlusal anatomy in either case) that is worn continuously until the patient becomes asymptomatic (usually one to five days, with some adjustment of the splint necessary in severe or persistent cases).

#### Molding denture borders

After relaxation and a balanced muscular response have been achieved, a precise step-by-step procedure can be followed which allows the patient's own musculature to mold the borders of the previously prepared custom impression trays, systematically relieving pressure areas and filling voids as the impression is taken. A special, highly sensitive impression material, Myo-print®, must be used to ensure satisfactory results. The entire procedure is illustrated in the special technique manual "Superior Impressions for Complete Dentures."<sup>15</sup>

#### Summary

The Myo-monitor® transcutaneously stimulates the motor branches of the V<sup>th</sup> and the VII<sup>th</sup> cranial nerves, relaxes the associated musculature, and then records an occlusal position that is compatible with a continued state of relaxation. Additional techniques have been developed for taking denture impressions (or relining old dentures)<sup>16</sup>, functional occlusal diagnosis, occlusal adjustment, and treatment of T.M.J.-M.P.D. syndrome.

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(To be continued)

Original article:

### **The Myo-monitor: Its use and abuse (II)**

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In the previous issue (Part I) the Myo-monitor<sup>®</sup> was described as a neuromuscular stimulator<sup>1, 2, 3</sup> that is used in dentistry to relax the muscles of mastication. It is subsequently used to accomplish a variety of clinical purposes to record a neuromuscular occlusal position, to obtain a functional occlusal diagnosis, to obtain border molded denture impressions, to precisely identify functional prematurities (coronoplasty), and to provide for the diagnosis and more successful treatment of T.M.J.-M.P.D. dysfunction syndrome<sup>4</sup>. To successfully bring the benefits of neuromuscular occlusion to his practice, the dentist must discard the condylar border positioning concepts that have dominated occlusion for the greater part of a century. We must bear in mind that the complex, cumbersome armamentarium and the manipulative procedures for recording centric relation and border pathways induce muscle tension that is quite incompatible with the requirement of a relaxed neuromusculature, the basis for a neuromuscular occlusion. Because neuromuscular occlusion represents a significant break with the past, in effect a new era with occlusion, it requires instrumentation and technology designed to achieve and maintain a relaxed neuromusculature.

It is perhaps to be expected that with a background of half a century of indoctrination with the conventional gnathological condylar procedures, researchers would use these same methods to measure and evaluate neuromuscular occlusion. A review of the literature shows that this has indeed occurred. A description of some of the mechanical, technical, and conceptual inconsistencies should be of help in avoiding these abuses in the future. Some examples of things to avoid are given below:

#### **1. Introduction of mechanical devices**

Any mechanical device, when introduced into the mouth, adds mass and weight to the mandible and/or maxilla and induces neuromuscular excitement. The introduction of such devices constitutes a violation of the technique and will negate the possibility of producing an accurate myocentric result.

An obvious example of mechanical interference is the use of clutches attached to the teeth. The additional weight, the proprioceptive effects, and the interference with the occlusion obviate the possibility of producing an undisturbed neuromuscular response. In one published report<sup>5</sup>, the authors used intra-oral clutches to attach a 750-gram Stuart Pantograph to the subject. They then attempted to record the myocen-



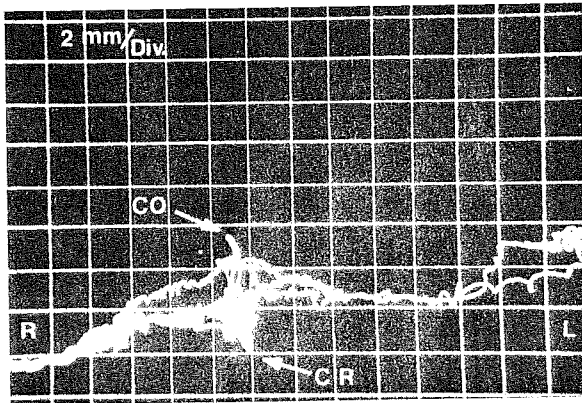


Fig. 5 MKG® recording of a gothic arch (horizontal plane) tracing beginning at centric occlusion (CO), retruding to centric relation (CR), moving right (R) and back to CR, and moving left (L) and back to CR. Note the erratic nature of the movement due to the muscle tension and the lack of consistency between outward and inward lateral movements from CR.

tric position. Since the presence of the apparatus excites the neuromusculature and alters the neuromuscular response, the procedure reflects a basic lack of understanding of the nature of myocentric occlusion. In another, similar report<sup>6</sup> intra-oral clutches were wired to the teeth to support protruding members, a vertical screw, and a tracing device (Hight tracer\*). These procedures are totally inappropriate and must be avoided when recording the neuromuscular occlusal position.

### 2. Inappropriate registration material and technique

The introduction of any registration material over the teeth alters the neuromuscular response to the Myo-monitor® stimulus. The procedures to minimize and correct the effect are detailed in the Myo-monitor® registration manual<sup>7</sup>. To conform to the requirements, registration material (Myo-print) was formulated to retain its shape (not slump) and yet offer almost no resistance to the Myo-monitor®-induced

myocentric closure. Yet, one study<sup>8</sup> utilized metal-reinforced wax for registering myocentric position! Because Myo-monitor®-induced closures terminate with minimal force, such metal-reinforced wax resists penetration during the closure; thus the wax, rather than the musculature, determined vertical dimension. Though the investigator failed to monitor or control the vertical or lateral dimensions, it can be safely assumed from the data that the registrations were taken at an excessive vertical dimension\*. It is interesting that even under such adverse conditions the antero-posterior position only varied  $\pm 0.2$  mm (approximately the thickness of two pieces of paper) in the average of ten successive recordings on the same subject.

### 3. Improper electrode interface

It is important to realize that the electrode interface between the Myo-monitor® and the patient was specifically engineered for the purpose and is a significant part of the design<sup>9</sup>. When

\* Hanau Teledyne Dental Equipment Co., Buffalo, New York.

\* The average myocentric position was found to be posterior to the average centric occlusal position indicating an "over-open" condition.

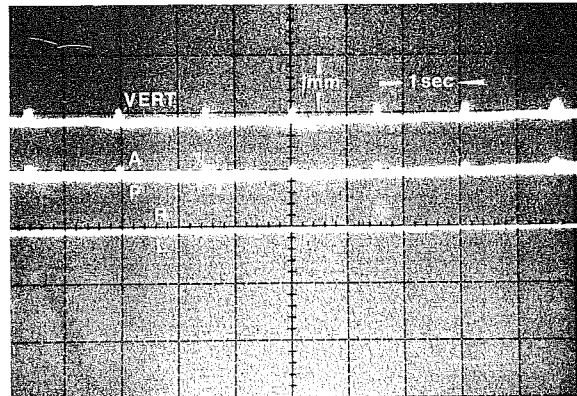


Fig. 6 A sweep MKG<sup>®</sup> recording of rest position (10 overlapping traces) after 30 minutes of Myo-monitor<sup>®</sup> pulsing. Note the stability of the rest position and the repetitiveness of the Myo-monitor<sup>®</sup>-induced muscle responses

electrodes other than Myo-trodes are used or if the Myo-trodes are installed improperly (with an inadequate amount of gel, wrong location, etc.), the results will be altered. For instance, there is no practical way of applying the Myo-monitor<sup>®</sup> stimulus to a cat<sup>10</sup>, given its diminutive size, that would simulate the actual conditions of a human subject. Electrodes small enough to be used on the masseter muscle of an anesthetized cat would increase the effective stimulus strength approximately 100 times, allowing the muscle tissue to be depolarized directly by the stimulus rather than being stimulated indirectly through the motor nerve as it is in a human subject.

#### 4. Relaxation of the neuromusculature

The most crucial technical error in utilizing the Myo-monitor<sup>®</sup> is attempting to register myocentric position without first adequately relaxing the musculature by pulsing just above threshold amplitude for at least 30 minutes<sup>11, 12, 13</sup>.

In studies comparing repetitiveness of the gnathological centric relation position and the myocentric position, the

sequence of the registrations becomes crucial. The registration of centric relation, even briefly done, excites the musculature (Fig. 5). The excitement induced by the retrusion to centric relation then makes it impossible to register a myocentric position. Subsequent reduction of tension and relaxation of the musculature as shown in the Mandibular Kinesiograph<sup>®</sup> (MKG<sup>®</sup>) recording (Fig. 6) requires 30 to 40 minutes of subsequent Myo-monitor<sup>®</sup> pulsing before proceeding with myocentric registration.

*The ability of the Myo-monitor<sup>®</sup> to produce repetitively accurate myocentric closure depends upon first achieving a relaxed muscular state.* Investigators who did not include this requirement in the stated conditions of their experiments reported they were unable to obtain consistent results.

#### 5. Education in myotronic technology

With the advent of myotronics, dentistry is being introduced to a new, advanced electronic system that provides improved capability for the management of mandibular function and dysfunction. A change of such significance



requires that the researcher and the practitioner become proficient with the new methodology through education and by working in the field.

For instance, it has been clearly stressed in the literature<sup>2</sup>, in the technique manuals<sup>11, 12, 13</sup>, and at all Myo-monitor<sup>®</sup> training courses\* that the overclosure is only to be used briefly to obtain an "over" closure above the normal physiologic vertical occlusal level in the case of a severely worn dentition. *The use of the overclosure circuit while recording myocentric position<sup>5</sup> reflects a complete lack of knowledge of its proper use.*

#### 6. Control of posture

Change in posture shortens some muscles and lengthens their antagonists. When it is realized that postural changes affect the registration of neuromuscular occlusion, precautionary steps can be taken to assure a muscularly balanced posture during registration<sup>14</sup>. Balanced posture prior to taking a myocentric registration is essential during clinical use and must be a part of the protocol of any research project.

#### Discussion

Several positive statements can be made about the Myo-monitor technique from reviewing the literature to date:

- a) A repetitive myocentric position cannot be registered while a subject is fitted with a clutchmounted pantograph or tracing devices.
- b) Metal reinforced wax or any resistant or slumping material is not suitable for myocentric registration.
- c) Myo-trodes, designed specifically as a part of the myotronics system,

\* A list of courses given will be supplied on request.

must be properly located and installed.

- d) Muscle relaxation must be achieved preparatory to the application of any Myo-monitor<sup>®</sup> technique. Such relaxation must be stated as an important part of the protocols of any experiment, and failure to include this in the description flaws the investigation and causes questions as to the investigator's awareness of its importance.

In investigations that compare CR position with myocentric position, the sequence of the procedures is an important consideration and should be specified. Manipulating the mandible to CR induces tension and excitement. To then proceed with myocentric registration is futile because of the tension induced into the musculature by the previous manipulation to CR.

- e) A new modality requires the acquisition of new knowledge, skill, and education. Investigations based on little or no experience with the device serve only to mislead the reader<sup>5, 6, 8, 10, 14</sup>. They have no place in science.

#### Summary

In the field of mandibular function and occlusion, there has been a crying need for simplification, timesaving, and greater consistency of results. The increased sophistication represented by myotronic instrumentation is a large step in this direction.

The complicated mechanistic procedures and armamentarium of the past are now giving way to an improved physiologic approach that simplifies occlusal treatment, that recognizes the existence and the importance of the neuromusculature, and that can be applied in everyday practice.

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