03/04

by Clayton A. Chan, DDS, MICCMO

Applying the neuromuscular principles in TMD and orthodontics

Neuromuscular Dentistry = "Dentistry"

Neuromuscular dentistry goes beyond the hard tissues of the head and neck and includes the soft tissues, as well as muscles and nerves. Many dentists are realizing that there is more to a perfect bite than straight teeth. In dental school, we were taught that teeth are attached to the jaws, yet there are also muscles, joints, nerves and blood vessels that make up the whole head and neck complex. The meaning of the term "neuromuscular dentistry" has evolved to specifically distinguish itself from the traditional approach to clinical dentistry, since our traditional concept of dentistry has approached the functioning of the masticatory system from a mechanical perspective.[1,2]

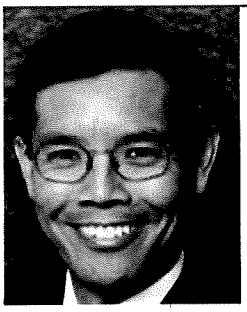
Nature does not think mechanically, but rather obeys the laws of bio-physiology as they pertain to the posture of the mandible to the skull. Neuromuscular emphasizes the innervation of the nerves to the masticatory muscles as they pertain to the "physiologic posture" when establishing an occlusion. Neuromuscular dentistry also recognizes that generic rules of physiology and pathophysiology, which apply to the skeletal muscles in other parts of the body, also apply to the masticatory muscles. The TMJ is a joint that follows the generic principles of any body articulation. It allows freedom of movement of the mandible, allowing the teeth to come together at a terminal contact position for stable occlusion. Establishing an occlusion based upon the most stable position and function of the temporomandibular joints and the most relaxed position and function of the masticatory muscles is a key component of neuromuscular dentistry. The neuromuscular principles follow all known parameters of medicine.[3]

Today, clinicians are recognizing that these profound neuromuscular concepts are nothing less than what our pioneering occlusion forefathers had acknowledged years ago.

"Some very innovative and forward thinking dentists who forged a broader perspective to dentistry in the early 1920s challenged the present beliefs and views of the time by broadening the perspective of what dentistry was about and refining mechanical measuring and recording instruments to understand mandibular movements as they related to occlusion. They emphasized that a thorough diagnosis and understanding of the mouth as a functioning unit was the basis of gnathological principles."[4]

In the past, these pioneering gnathologists were criticized among their peers. Yet, today, they have distinguished themselves as the ones who realized that occlusion's role in treating dental disease is something more than what the majority of dentists at that time realized. Today's neuromuscular clinicians are doing nothing less than fulfilling the past gnathologists' dreams by broadening our perspective of what dentistry is about and refining our understanding of mandibular movements as they relate to occlusion, muscles and the jaw joints. With today's computerized measuring and recording instrumentation and our understanding of neuromuscular principles, we can become physicians of the mouth. We have continued this journey to better understand the clinical dilemmas we all face by seeking scientific and rational answers to better serve our patients. Today's neuromuscular dentist is nothing less than a gnathologist - a physician of the mouth - fulfilling the dream of doing quality, comprehensive, aesthetic dentistry and what is best for our patients.

Dentists should all be "Physicians of the Mouth" who diagnose and treat the problems associated with the trigeminal nerve system, since this cranial nerve (V)



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is the "dentist nerve." Unfortunately, problems of the muscles and nerves are the least diagnosed and often overlooked, especially with the dental profession, which pays little attention to muscles and how they affect our patients' dental health.[5] Studies have indicated that 80 to 90 percent of all TMD problems are muscle-related.[6,7] Muscles and muscle health cannot be clearly seen on radiographic analysis nor diagnosed with an x-ray alone. The importance of muscles and their effect on dental occlusion (micro-occlusion) and the temporomandibular joints has been highly under-rated, although we superficially discuss the importance of the masticatory muscles in our profession.

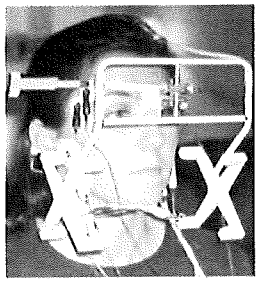
With bioinstrumentation, it is possible to determine a proper resting jaw position that positively affects the facial, head, and neck muscles and the teeth as well as the joints.

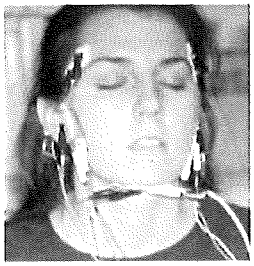
Technological advances have been developed for the clinical dentist to see muscle responses come alive as they relate to mandibular positioning and occlusion. With these objective and dynamic measuring tools, the dentist can visualize physiologic responses and better assess and monitor patients in a manner that surpasses traditional manual manipulative techniques and subjective feelings. With this bioinstrumentation, it is now possible to see whether treatment is effective and when a bite relationship is optimal. Muscles have now come alive through electromyography and computerized mandibular scanning![8]

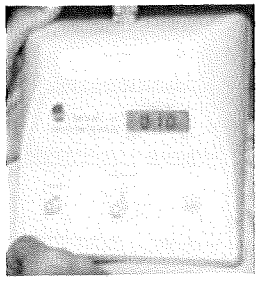
■ **Computerized Mandibular Scanning (CMS)** — Measures jaw movements and locates mandibular position in space, giving the clinician new insights into the stomatognathic system that have been unseen by traditional occlusal approaches.[9]

Surface Electromyography (EMG) — Measures the status of a muscle, giving new understanding to the importance of mandibular positioning and the health of the masticatory muscles. By placing adhesive surface EMG electrodes over particular muscles of the face, head or neck, it is possible to monitor the amount of tension in these muscles. This gives us an objective way to measure how much hyper-tonicity (tension) a muscle is experiencing.


Before treatment


Computer mandibular scanning


Electromyography


Myomonitor

Electrosonography (ESG) — Measures high and low frequency joint sounds. The popping, clicking and grating crepitis sounds during opening and closing movements can be detected, analyzed, and documented.

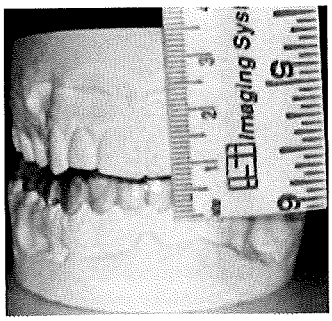
Ultra Low Frequency Transcutaneous Electroneural Stimulation Myomonitor (TENS) — Physiologically relaxes the masticatory muscles via neural stimulation of the trigeminal (V) and facial (VII) cranial nerves synchronously and bilaterally. This electrical stimulation of the muscles helps to deprogram them in order to find the resting position of the mandible where muscle tension is minimal. We now have a finishing point to work toward that is reproducible and comfortable to the patient.

Neuromuscular orthodontics emphasizes a need to find an optimal antero-posterior position of the mandible along an isotonic path of closure, an optimal intraoral and extraoral muscle balance of forces (symmetric vs. asymmetric), and an optimal finished occlusion (micro-occlusion) that harmonizes with the jaw joints. Proper meshing of the teeth so that they function in harmony with the jaw joints and muscles will allow teeth to wear and function evenly, be stable, and decrease trauma to the surrounding supporting bone. Rather than guessing subjectively and assuming the jaw trajectory is correct, the above instrumentation assists in identifying a correct jaw position before orthodontic treatment begins and after orthodontic treatment. Harold, Bowbeer, Beistle, Witzig and Spahl are just a few of the investigators who have published sufficient evidence to substantiate that "stable treatment results depend upon establishing a balanced neuromuscular function of the craniofacial muscles which support the structures at their optimal position."

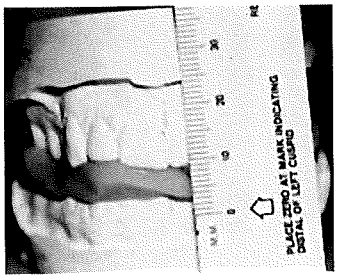
Case study

A Caucasian female, age 19, experienced the following:

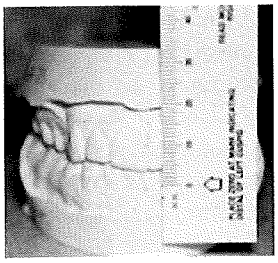
- Excruciating pain in the muscles around her jaw bilaterally for the past three years.
- Previous orthodontic therapy.
- She had seen two previous dentists, specialists, and a massage



Diagnostic casts in centric occlusion



Casts mounted with myocentric blue



Casts mounted with neuromuscular orthosis at myocentric position

therapist with limited improvement.

- She has had her teeth adjusted.
- Doctors concluded that muscle spasms were due to teeth grinding. She was placed on a "soft food diet." She said she was eating with her tongue between her teeth.
- Isometric exercises were recommended. She was instructed not to sleep on pillows. A hard splint was made which provided limited relief.
- Another dentist prescribed muscle relaxants, ibuprofen, and sleeping pills, along with hot packs, which provided no relief from pain.
- A fifth doctor reshaped teeth and made a soft splint for the lower jaw (worn at night). The symptoms worsened.

A thorough evaluation was completed which included:

- Health history
- TMJ screening questionnaire
- Initial consultation
- Clinical examination
- Diagnostic records - study models, intraoral and extraoral photographs, along with a complete K7 neuromuscular work-up, including EMG scans 9, 10, 11 and CMS scans 2, 6, 13, and 4/5. (Myotronics K7 Kineseograph, Tukwila Washington, USA)
- Delivery of a lower mandibular orthosis was indicated for stabilization and verification was made using the Myotronics K7 Kineseograph.

A thorough examination concluded that the patient presented with musculoskeletal dysfunction of the head and neck (MSD), resulting in temporomandibular joint dysfunction. Muscle palpation examination revealed numerous muscles that were tender to touch. These hyperactive muscles were found to trigger the numerous symptoms of temporal headaches, muscle tenderness, sub-occipital neck aches, pressure behind the eyes, feelings of ear congestion (stuffiness), and teeth sensitivity, to name a few.

Radiographic evaluation included: panoramic, submental vertex, tomograms, lateral cephalograms and lateral cervical spine films which revealed that both condyles

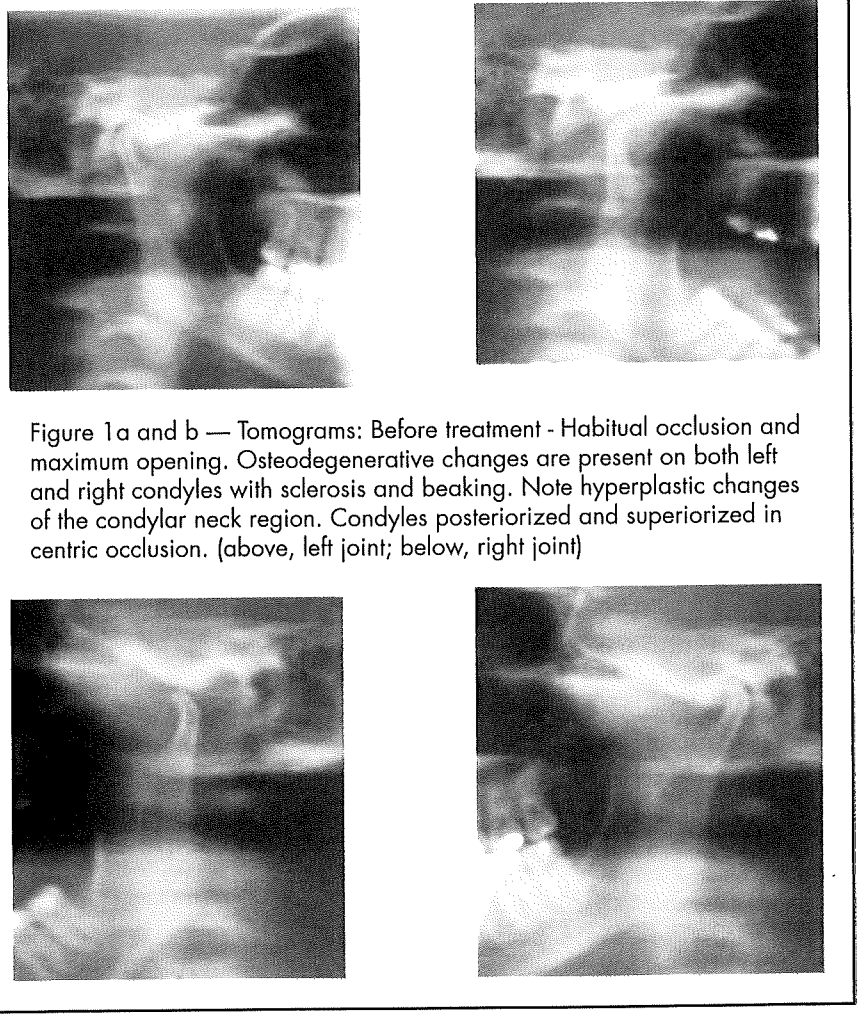


Figure 1a and b — Tomograms: Before treatment - Habitual occlusion and maximum opening. Osteodegenerative changes are present on both left and right condyles with sclerosis and beaking. Note hyperplastic changes of the condylar neck region. Condyles posteriorized and superiorized in centric occlusion. (above, left joint; below, right joint)

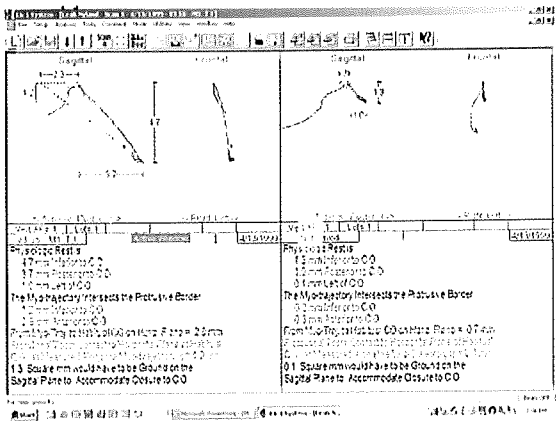


Figure 3 - Computerized mandibular scan (sagittal and frontal views) showing (a) physiologic rest position and neuromuscular trajectory before TMD treatment and (b) after completion of orthodontic therapy.

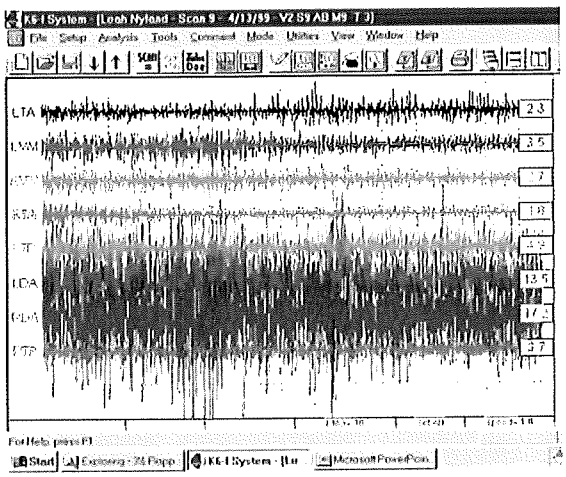
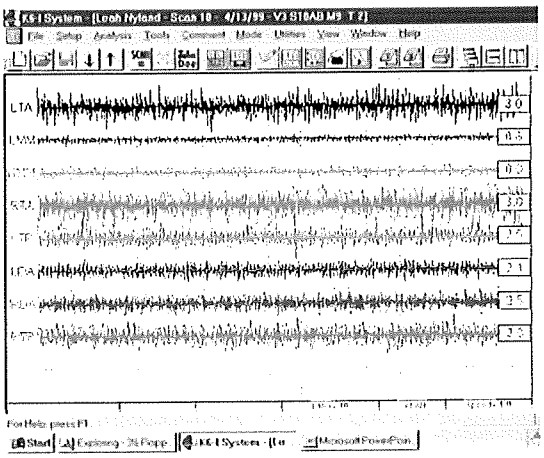


Figure 4a (above) — Resting surface electromyography before treatment showing hyperactive muscle activity.
Figure 4b (below) — Lower resting EMG recordings after one-hour Myomonitor TENS.



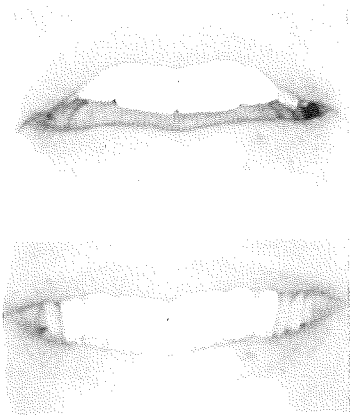
were posteriorized and superiorized in the habitual centric occlusion with osteodegenerative changes (Figure 1).

Dynamic functional and resting electromyographic (EMG) tests for muscle status, along with computerized mandibular scanning (CMS), revealed impaired muscle function and reduced mandibular movements in the habitual occlusion. Further EMG and CMS tests indicated that an improved maxillomandibular posture could be determined to "physiologically" establish a more optimal occlusal relationship for improved muscle rest and function.

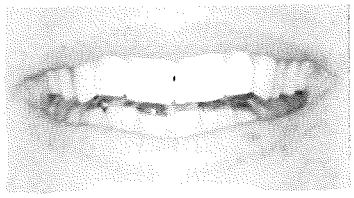
Phase I-TMD stabilization treatment was rendered using a lower anatomical orthosis (Figure 2). A physiologic rest position (myocentric) was first determined in both the vertical, sagittal and frontal dimensions by visual aid of computerized mandibular scanning (Scan 4/5) after Myomonitor TENS of 60 minutes. Physiologic rest was identified objectively using simultaneous monitoring of CMS and EMG recordings after TENS to observe a repeatable base line vertical, sagittal and frontal position after postural resting modes of muscle activity were established (Figure 3). The measured and recorded data validate optimal physiologic parameters to identify an optimal starting point for TMD treatment, thus reducing mandibular torque, strains and skews that can be produced by hypertonic musculature. A bite registration using Sapphire (Bosworth) was used to capture a targeted (myocentric) position with the patient in an upright position. Both the mandibular position (CMS) and muscle activity (EMG) were simultaneously monitored and recorded after Myomonitor TENS therapy to identify and confirm an optimal vertical, sagittal and frontal position before treatment began. Low EMG recordings with the visual aid of observing mandibular position confirmed an optimal physiologic mandibular position to begin treatment (Figures 4a and b). At no time was the mandible manually manipulated or touched during bite registration.

The patient was stabilized for 13 months with the neuromuscular lower orthosis. Slight occlusal adjustments were made over the

Figure 2 — Anatomical lower orthotic

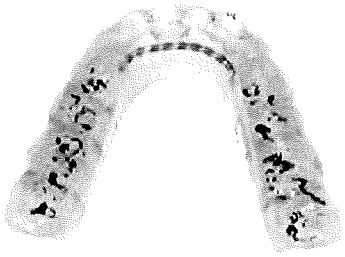


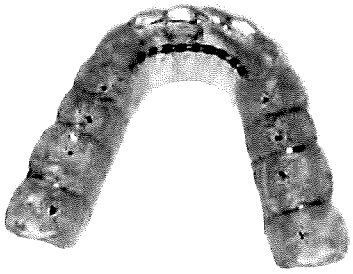
Habitual position before treatment



Neuromuscular/myocentric position with orthotic

Neuromuscular orthotic at myocentric position



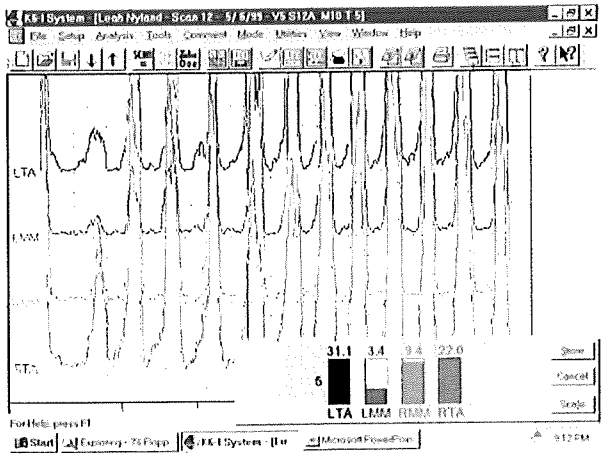


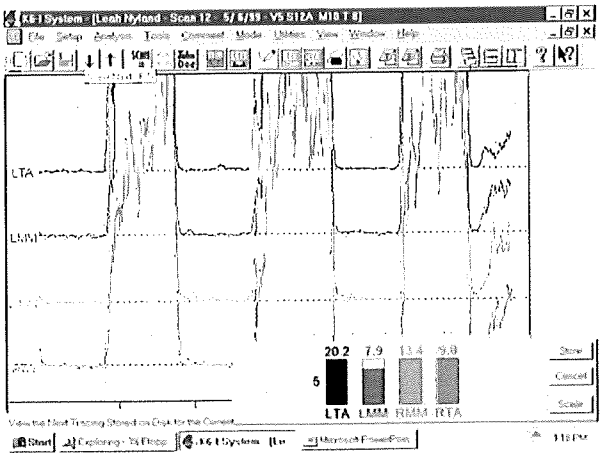
Coronoplasty/micro-occlusion is the removal of any noxious proprioceptive stimuli triggering muscle imbalance and impaired mandibular movements.

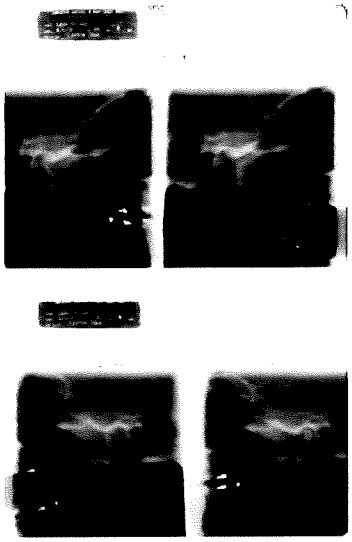
first six-month period of initial therapy. The orthotic adjustments were made at the four-week period, two-month period and at the six-month period.

Enhanced functional EMG data were also used to magnify mandibular torque of both the temporalis and masseter muscles, first tooth contact patterns to refine micro-occlusal, pre-mature interfering inclines during terminal tooth contact to satisfy the fine proprioceptive noxious stimuli that trigger abnormal muscle responses of pain. Technological advances in EMG recordings are able to help guide the clinician in refining occlusion to identify fine proprioceptive interferences during closure and function for patient comfort (Figures 5a and b). Balanced occlusion was developed with both muscle groups activated simultaneously on dental closure. Fine micro-occlusal adjustments (coronoplasty) were made to keep pace with the normalizing temporomandibular joints, which were previously posteriorly and

Figure 5a (left) — Functional EMG display of mandibular torque before orthosis was adjusted, indicating premature tooth contact in left second bicuspid area.
Figure 5b (right) — Functional EMGs after coronoplasty adjustments, indicating balanced occlusion.







Figures 6a and b — Tomograms: Progress (with orthosis). Patient asymptomatic at neuromuscular position. Note condyles have come down and forward. Left (top) and right joint (bottom).

superiorly positioned within the glenoid fossae. Facial aesthetic improvements, along with masticatory and postural muscle comfort, were re-established. Headaches were dramatically resolved by establishing a physiologic neuromuscular trajectory and occlusal stability to satisfy the spastic warring between muscles, temporomandibular joints

Six months stable and asymptomatic wearing a lower orthotic

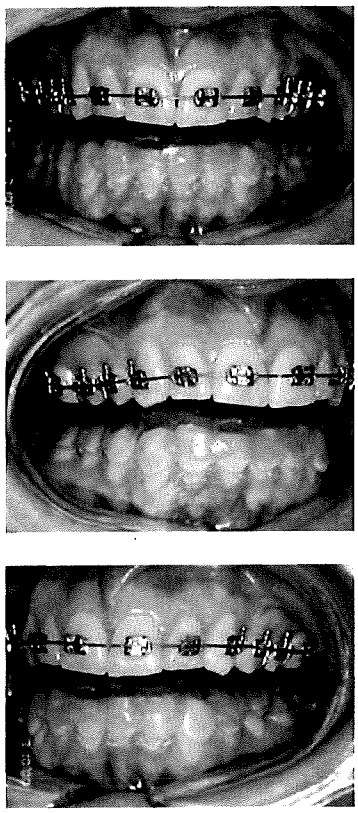


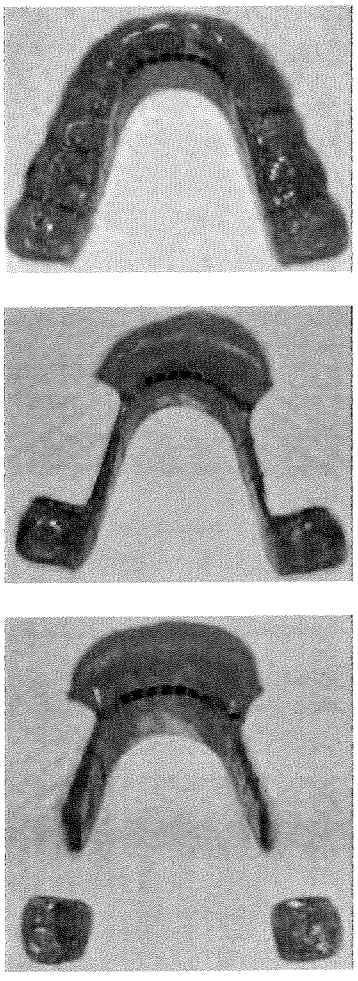
Figure 7

and occlusion (Figure 6a and b).

After a physiologic and aesthetic relationship was determined and proven with the orthotic therapy, a Phase II orthodontic therapy was implemented using a combination approach of both functional appliances and fixed wires and braces to develop and move the surrounding periodontium and teeth to the predetermined neuromuscular position that was objectively determined with EMG and CMS recordings.

Maintaining the proven neuromuscular position and transitioning from the orthosis to natural dentition was accomplished by the following steps:

- Upper and lower arches were developed using functional appliances (Schwartz appliance) with an expansion screw that the patient adjusted every week.
- Fixed mechanics/ braces using the straight wire technique and light wire systems were used to level, align and rotate teeth as simultaneous arch development took place (Figure 7).
- The existing orthotic was continually worn as sequential steps were taken to remove and modify the lower orthotic appliance in a tripod format to maintain the neuromuscular position throughout treatment.
- Eventual separation of the second molar pads from the rest of the original orthosis was accomplished



Figures 8a

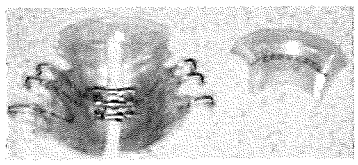


Figure 8b

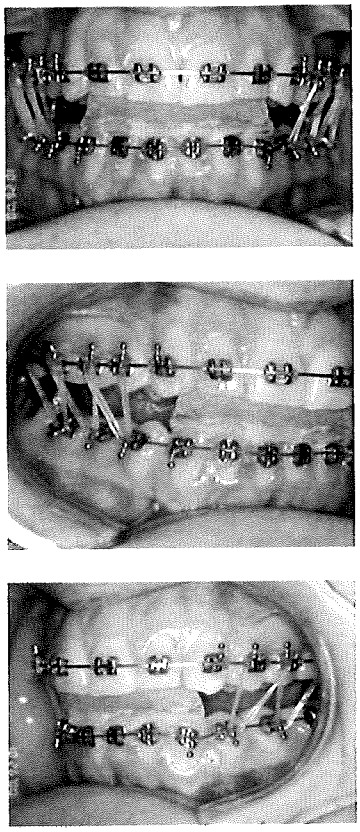


Figure 9

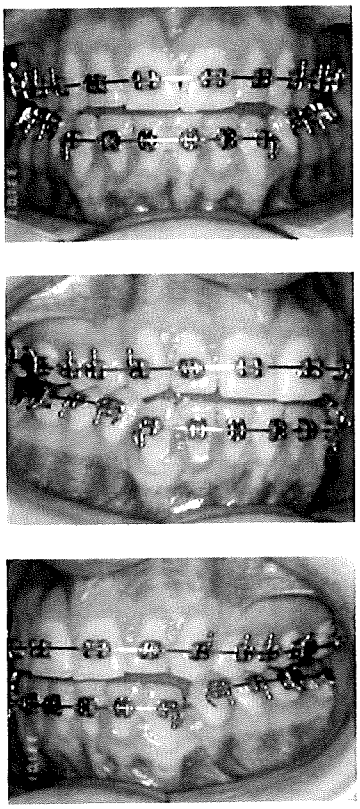


Figure 10

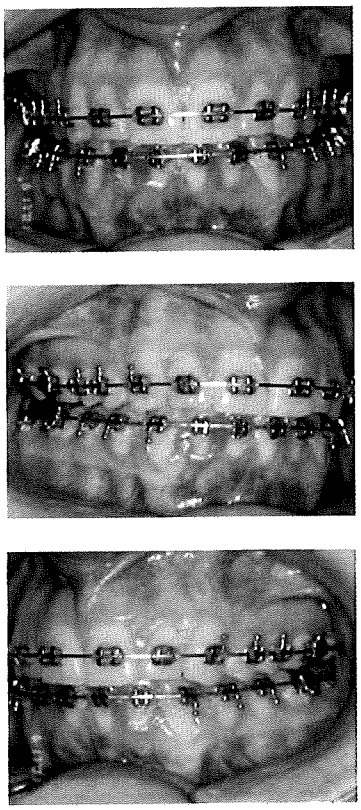
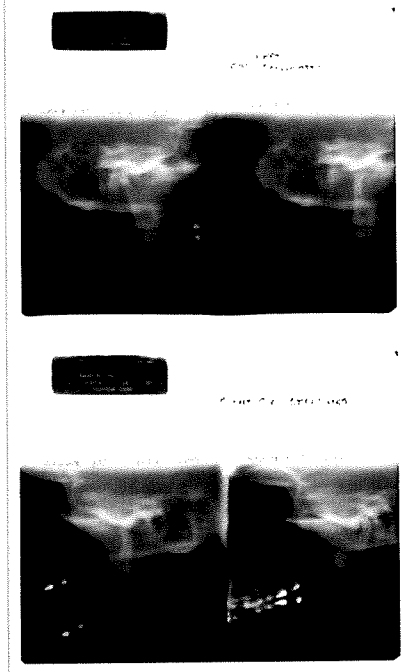


Figure 11



Finishing tomograms — Just prior to bracket removal at neuromuscular position (left and right joint).

and bonded to the second molars. A removable anterior segment along with the bonded second molar pads was used to assist in maintaining the mandibular to maxillary relationship (Figures 8a and b).

■ Verticalization and upward development of the lower arch to the predetermined position were accomplished using triangulating elastics (Figures 9, 10).

■ Once the lower left and right bicuspids and lower first molars were in contact, the anterior segment of the orthosis was discontinued and full arch wire mechanics were implemented to verticalize and develop the lower anterior teeth (Figure 11).

■ Once a stable occlusion was established and the patient continued to be asymptomatic, the remaining second molar pads were removed and verticalizing elastics were used to erupt the second molars to complete the orthodontics treatment (Figure 12).

Neuromuscular orthodontics was completed in 13 months with sim-

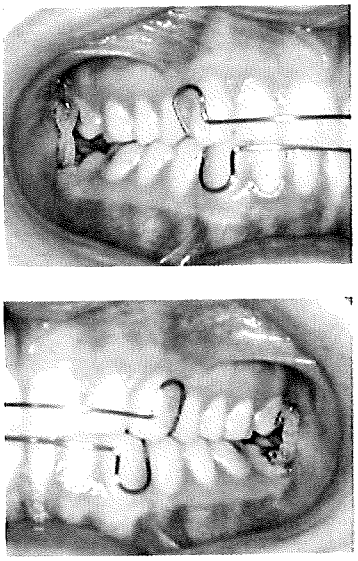


Figure 12

ple straight-wire techniques, allowing light and continual forces to activate the surrounding bone and natural dentition to the pre-determined and measured physiologic position. The upper arch was horizontally developed 4.5 mm using the upper Schwartz appliance and braces. 3.7 mm of vertical was accomplished, leaving a 1.3 mm physiologic freeway space. An anterior-posterior discrepancy of 2.3

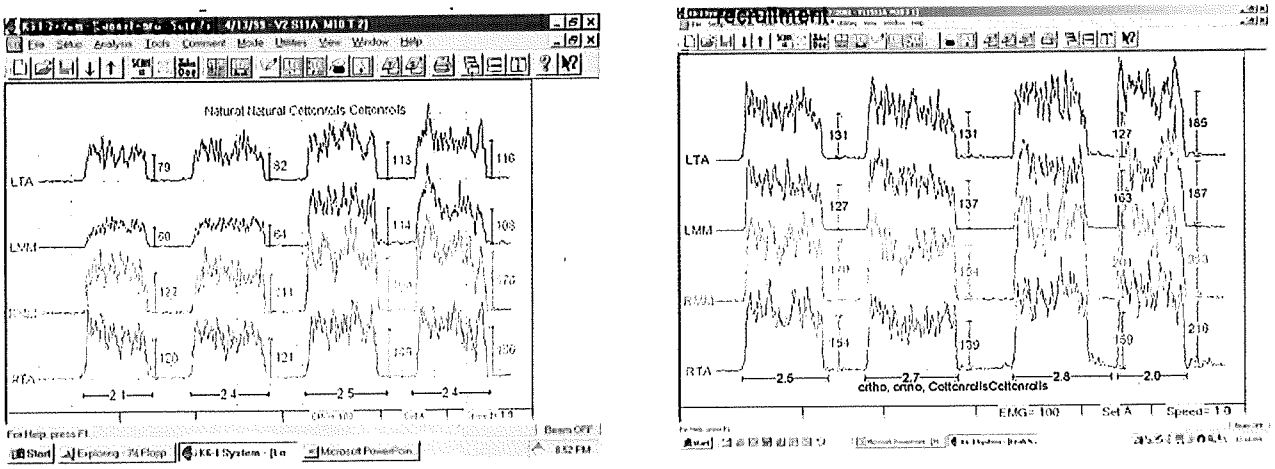


Figure 13a (left) — Before-treatment functional EMGs, indicating lower left masseter and anterior temporalis muscle recruitment during natural clench test compared to cotton rolls used as the control.
Figure 13b (right) — After orthodontic treatment, indicating balanced muscle recruitment of both the anterior temporalis and masseter muscles - improved function and muscle recruitment.

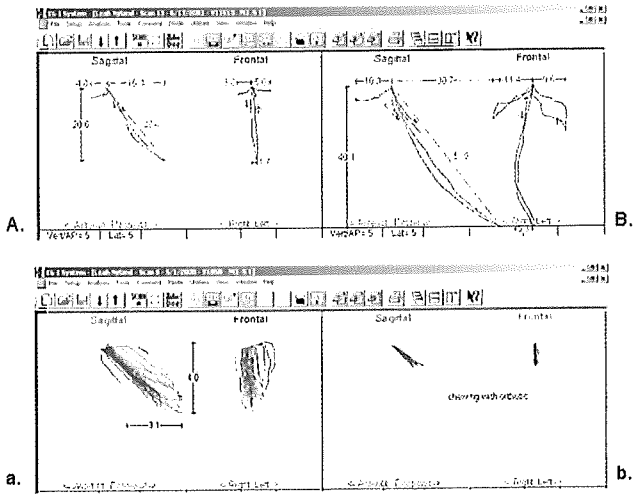
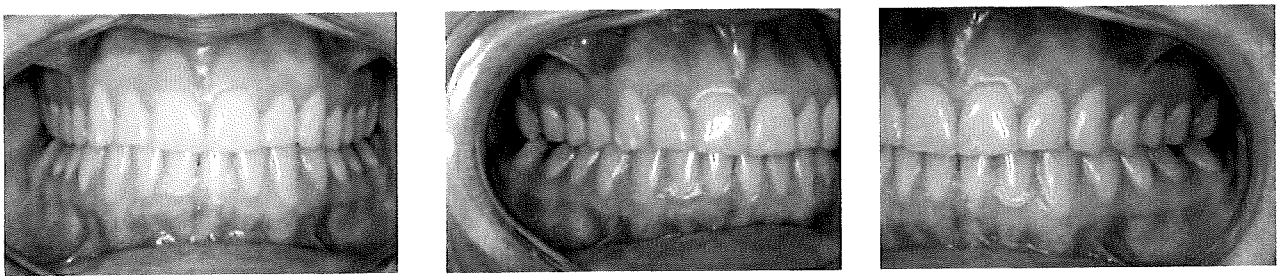
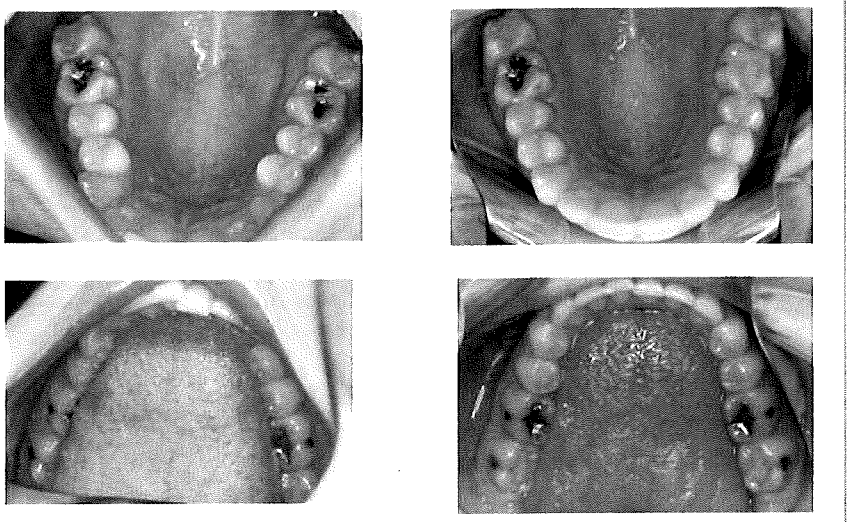


Figure 14 (top) — CMS recordings of mandibular range of motion indicate improved function. (a) Restricted range of motion before treatment. (b) Increased range of motion after neuromuscular treatment.

Figures 15a and b (bottom) — Chewing cycles (a) Before treatment, chewing cycles indicate non-repeatable centric terminal position with guarded occlusion. (b) After neuromuscular orthodontics, indicating precise occlusion free of interferences during exit and entry into a terminal contact position.



Finished treatment.



Before treatment and after orthodontic treatment.

Patient asymptomatic after three years of chronic TMD pain. 13 months orthotic stabilization, 13 months orthodontic treatment to neuromuscular position.

mm was corrected from the previous habitual path of closure to the pre-determined neuromuscular trajectory (Figure 3).

Muscle activity was again tested, verifying low resting EMG during postural rest before and after TENS and balanced functional EMG, Scan 11 (Figures 13a and b), to validate optimal muscle recruitment after orthodontic therapy during clenching modes. CMS scans also confirmed improved range of mandibular motion after neuromuscular treatment, compared to the previous restricted maximum incisal opening and lateral excursive mandibular movements (Figure 14). Electrosonographic analysis of both joints indicated a decrease in amplitude and frequency of joint sounds. Functional chewing cycles (Figures 15a and b) displayed improved and precise terminal contacts during opening and closing movements after treatment.

The TMD patient has been greatly misunderstood by many to be only the whining and complaining type of patients. These wonders within the medical/ dental community are often not desirous because of misunderstandings of their problems and are often thought of as the emotionally unstable, psychologically impaired, and the crazies. Amazingly at first glance, many clinicians would not recognize a TMD patient unless they presented to the office exhibiting one or more of these traits. On further evaluation and inquiry, it soon becomes apparent that musculoskeletal occlusal/ TMJ signs and symptoms that are hidden do exist. As Dr. Robert Jankelson has stated in the past, "The less you know, the more normal your patients appear."

Thanks to the progress of available innovative technology, clinical dentists are now able to better assess, diagnose, monitor and treat their TMD, orthodontic and restorative patients more effectively with the aid of objective data for predictable treatment outcomes.

References

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