FORM FOLLOWS FUNCTION

Keys to Facial Beauty & Expression Involve Maxillary Arch Form and Development

By Clayton A. Chan, D.D.S.

> "The origin, development and maintenance of all skeletal units are secondary, compensatory and mechanically obligatory responses to temporally and operationally prior demands of related functional matrices."
>
> ***Functional Matrix Hypothesis – Melvin Moss***

The ultimate goals and responsibility of the orthodontic therapist is to treat all three components of the stomatognathic system to create an environment for synergistic function of the teeth, temporomandibular joints and neuromuscular system. A balanced cranio-mandibular cervical relationship must exist in order to establish acceptable dento-facial beauty, balanced masticatory muscle forces on the teeth (intra and extra oral) that are positioned within a neutralizing zone of muscle forces that will support long term occlusal stability and good periodontal health.

Soft tissue facial changes in adults and children with Class I or mild to moderate Class II malocclusion, treated with removable orthopedic appliances have been shown to improve facial profiles. In addition, up to a 30 percent relative increase in the mid-palatal region with shape changes consistent with improved dental facial alignment in maxillary transverse directions has been shown to occur. (See Figure 1-7)

Figure 1: Note the subtle resulting facial changes that occurs around the eyes and lower one third the face of this TMD paining patient (age 36) face after wearing a neuromuscular mandibular orthosis.

Figure 2: Mandibular orthosis worn 11.5 months for cranio-mandibular stabilization prior to orthodontic/orthopedic treatment.

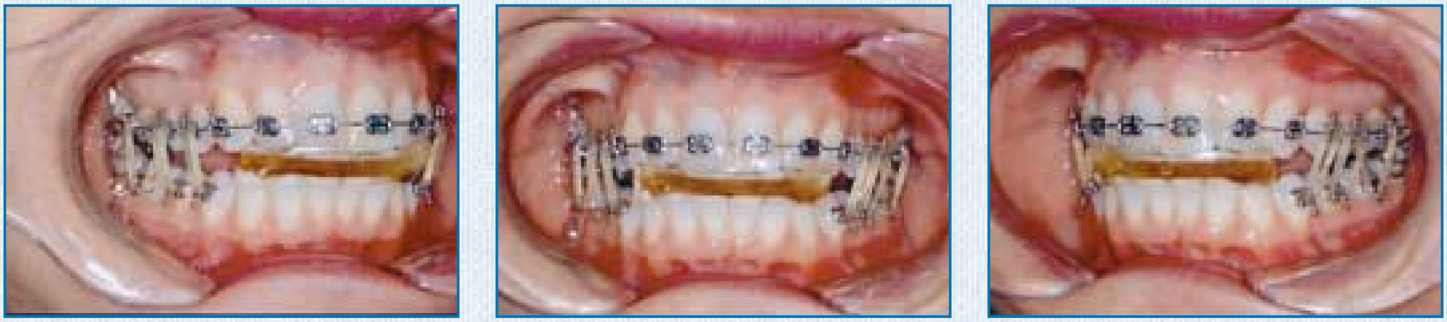

Figure 3: Upper straight wire arch anchorage unit developed with a lower tripodizing appliance (anterior region and second molars) to hold the mandible in the neuromuscular position. 3/16 inch 6 oz. triangulating elastics are used to verticalize the bicuspids and first molars to the neuromuscular position.

Figure 4: Mandibular posterior teeth are beginning to contact holding mandible and condyles in stable functional position.

Figure 5: Once solid occlusal terminal contacts are established the second molar pads are removed to allow final stages of verticalization to neuromuscular position.

Figure 6: Blue marks indicate terminal contacts at the neuromuscular position (myocentric).

Figure 7: Finished bite. Patient no longer is experiencing TMD pain.

TEETH TOGETHER

Figure 8: Note the hyperplastic change in the condylar neck (bend) resulting from chronic posterior hypo-occlusion. During habitual resting modes the mandible and condyles seek a more down and forward homeostatic position within the glenoid fossa before any treatment. Stabilization of the mandible to a neuromuscular position will assist in triggering cellular stimulation, growth and regeneration of the joint complex.

REST POSITION

A 10 percent increase was localized in the nasomaxillary region and this also resulted in improved nasal, zygomatic and perio-orbital structures.[3] Thus we can consider it possible to remodel the functional matrix and establish sutural homeostasis of our dental patients with simplicity and ease.

It is commonly stated within our dental profession that dentist's shouldn't change bites, bones don't move, palates and dental arches can't expand (develop or remodel), and condyles don't remodel, especially in more mature adult stages of life. To make these claims disregards the dynamics of the human living system as an entity that constantly undergoes cellular changes throughout its lifetime. Science, technology and radiographic records of facial development and an understanding of the dynamics of mandibular positioning and stabilization have shown differently.

It is surprising that many dentists continue to believe that adult bones of the stomatognathic system no longer can change (see Figure 8). Neuro and physiologic science is clearly proving these past myths are unfounded and not true. Craniofacial development is clearly evident in many cases that have been treated neuromuscularly, especially when working within the functional matrix of the jaw bones. The communication of genes and their signaling by transmitted information into the boney cells will naturally produce facial expressions of phenotypes of nature's genetic potential in each human being. Genes can be turned on through mechanical transmission with proper stimulation of cells that can trigger responses to growth and development within the neuromuscular occlusal system.

"The human body is an extremely complex mechanism composed of many self maintaining, self regulating, and autonomous systems. The motor system allows movement and is comprised of three interrelated anatomical systems: the skeletal system, which provides the bony levers which generate motion; the muscular system, which supplies the power to move the levers; and the central nervous system, which directs and regulates the activity of the muscles. The central nervous system controls and operates this system through neural control of muscle tension. This complex system obeys the laws of mechanics, including both static and dynamic relationships."[1] Static relationships relate to bodies at rest and forces of equilibrium. Dynamic relationships relate to bodies in motion. The static functioning of muscle maintains equilibrium of the supporting bones and teeth, while the dynamic functioning results in visible motion of these entities.

The Dynamics of Mandibular Posture

Posture represents the spatial relationships of the skeletal structures to one another.[1] There exists a particular spatial relationship of each cervical neck bone as they relate to the occiput. A spatial relationship exists in multiple dimensions of each condyle within the glenoid fossae as the mandible is at rest and in dynamic function. When at rest, the mandible is in a state of static equilibrium maintained by a delicate balance of muscle forces pulling from above by the tonus of muscles of mastication and from below by both the hyoid bone musculature and gravity. The clinician should consider the spatial relationship that exists between the upper and lower arch of teeth. Still further, the clinician should recognize each skeletal occlusal joint articulates from a resting state of equilibrium to the dynamic articulated state of a terminal contact position during mandibular function back to its resting position. Figure 9 and 10 shows the effects of proper mandibular positioning via neuromuscular orthosis therapy and its impact on cervical neck postural alignment without other adjunctive interventions. This is clear evidence that the occlusion and its impact on proper jaw positioning can improve cervical neck musculature and the accompanying cervical bone alignment.

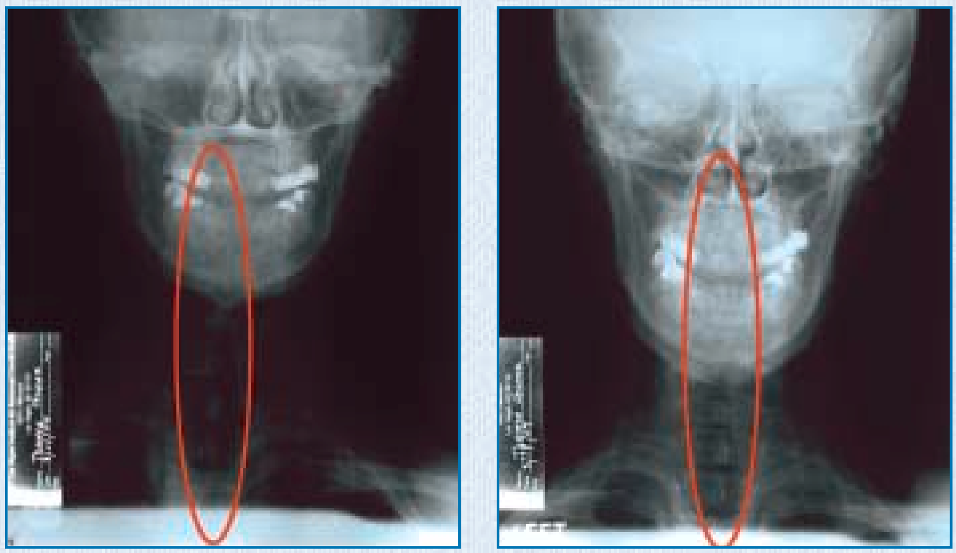

Figure 9: Lateral cervical spine radiographs showing cervical bone alignment after two day wearing a lower neuromuscularly positioned orthosis. This 51 year old female TMD patient, who presented with severe head and neck pain, no longer complains of TMD pain.

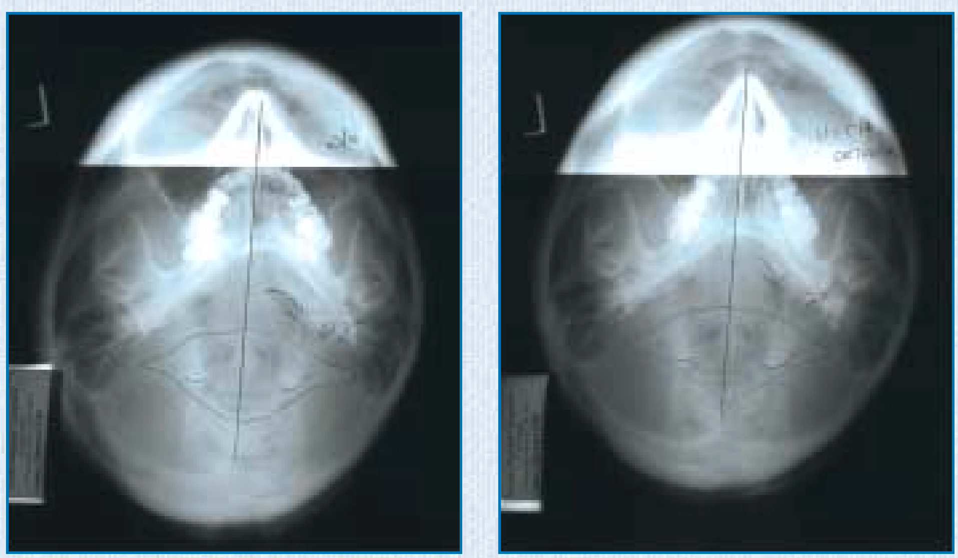

Figure 10: Submental vertex radiograph view of the atlas (C-1) of the same female patient. Note the alignment of the atlas after two days wearing the neuromuscular orthosis.

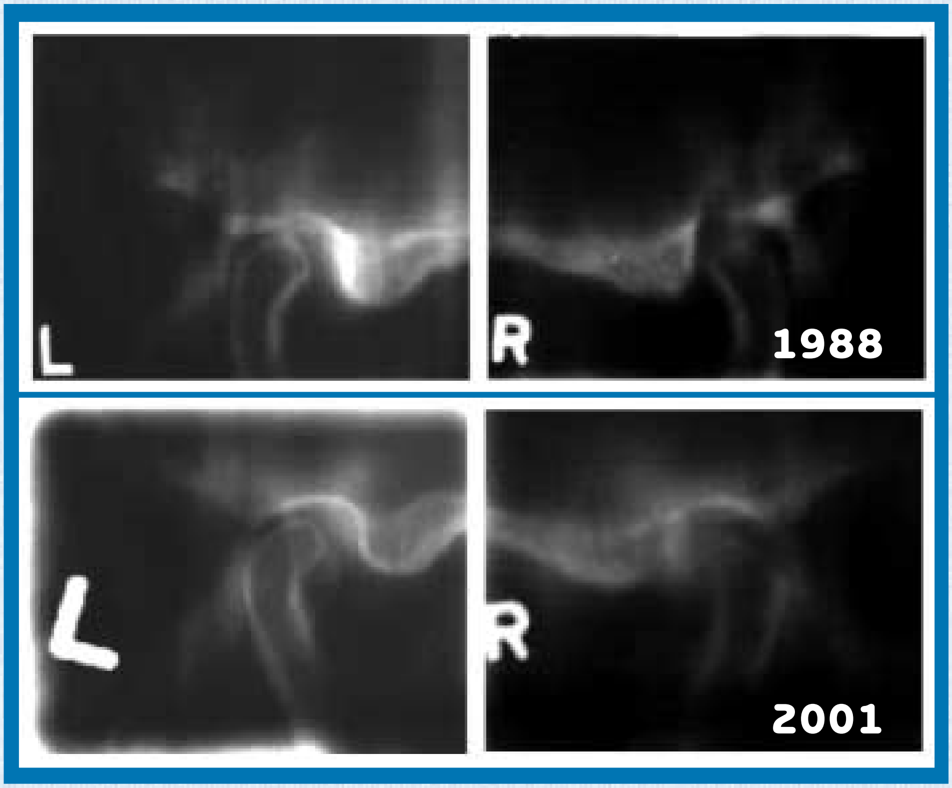

Figure 11: **13 YEAR TOMOGRAPHIC STUDY**
Adult Male – *Condylar Adaptive Changes*
Note the visible hyperplastic bony changes (bend in the condylar neck) of both left and right joints over a thirteen year period. For comparative purposes the tomographic films are the same corrected cut views thirteen years apart.

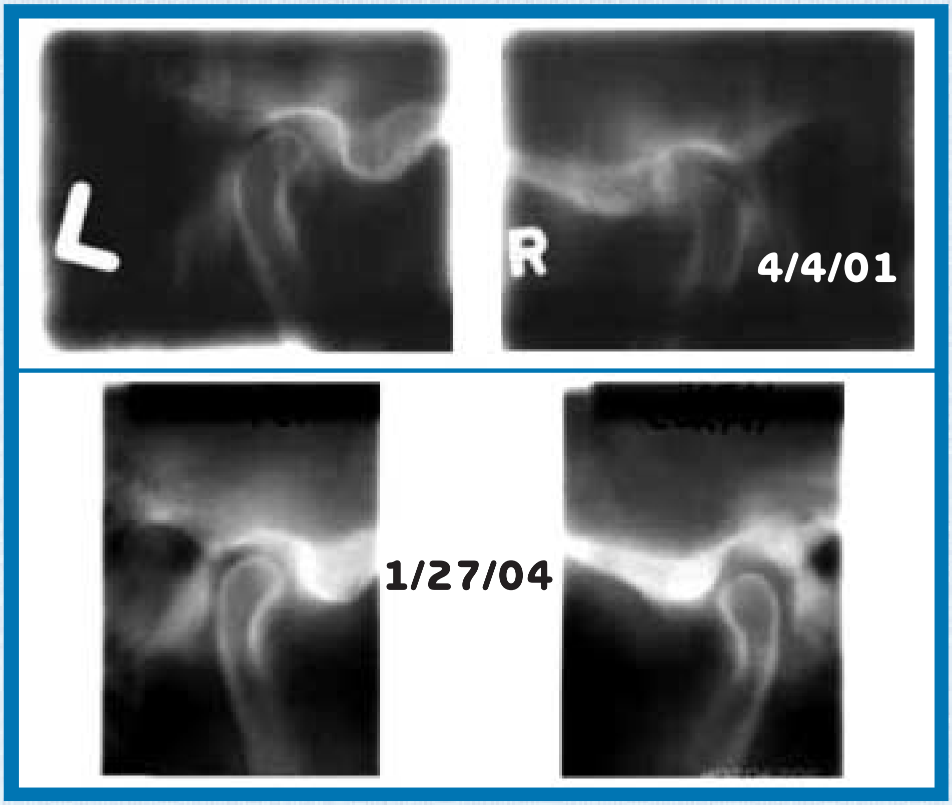

Figure 12: **3 YEARs After Nuromuscular Treatment with Mandibular Anatomica Orthosis – *Condylar Remodeling (Regeneration)***
Note the visible reversal of condylar neck changes (less bend in the condylar neck) of both left and right joints over a three year period due to decompression of the joints. Remodeling of both condyles occurred after the mandible was stabilized at the myocentric position with an orthosis and later full mouth reconstruction.

Teeth and Skeletal Components

The teeth are in essence an articulating extension of the bony skeletal structures. Bone is a living tissue composed of a protein matrix with mineral salts such as calcium, phosphorus, magnesium, sodium, and potassium, but even though it is one of the hardest body tissues, bone is nonetheless highly plastic and sensitive to the functional demands placed upon it. The internal structure of bone adjusts to modification from mechanical stresses; a fundamental principle of bone physiology is that form conforms to function. The mandible and maxillofacial bones obey the laws of biophysiology and are amenable to change during growth and development.

During the growth period of the mandible, bone is deposited upon the outer cortical layer of compact bone, and simultaneously the inner structure is modified. The adult bone particularly the alveolar bone is maintained in a healthy normal state by stimulation from teeth in function. Alveolar bone remains healthy and dense when intermittent moderate stimuli are transmitted by the teeth in a physiologic occlusion.

Ruf and Pancherz, 1999, reported in a prospective longitudinal magnetic resonance imaging and cephalometric radiographic study, signs of condylar remodeling in the postero-superior border in 48 of 50 adolescent condyles and in 26 of the 28 young adult condyles. Bilateral remodeling of the mandibular ramus could be detected in 1 adolescent and 2 young adult patients. Signs of glenoid fossa remodeling at the anterior surface of the post glenoid spine were also noted in 36 adolescent and 22 young adult temporomandibular joints. Effective temporomandibular joint changes during treatment were more horizontally directed and larger in both adolescents and young adult patients after Herbst appliance therapy than in an untreated group of subjects with ideal occlusion (Bolton standards).[4]

Temporomandibular Joint Changes With Removable and Fixed Appliances

Dr. Gary Wolford, a noted oral maxillo-facial surgeon in 2004, reported bilateral radiographic condylar adaptive joint changes over a thirteen year period of an adult Caucasian male, age 45. The patient demonstrated an audible reciprical click of the left joint with accompanying musculoskeletal occlusal signs and symptomology of the head and neck region before treatment. When treated with three months orthosis therapy and later a full mouth reconstruction at the myocentric position, condylar regenerative/remodeling changes were noted on both left and right joints over a three year period. The patient was subsequently restored to that proven and comfortable position with no resulting clicking and or popping joints. (See Figure 11 and 12).[5]

The mandibular condyle plays a significant role in giving indispensable latitude for adaptive growth; it provides a means for endochondral bone growth in a situation in which ordinary periosteal intramembranous growth would not be possible. It is also all too frequently involved in TMJ (temporomandibular joint) pathology and distress. Not only is the condyle able to undergo growth and adaptive changes, but the whole ramus is also involved.

Enlow stated that mandibular growth can be stimulated when a force is applied to the mandible, causing bone remodeling on the condyle and glenoid fossa <6>. If this is valid, this secondary growth can preserve the condyle relationship within the glenoid fossa while the visco-elasticity of muscle tonicity along with gravitational forces on the mandible positions the mandible in a down and forward direction (see Figure 13). Clinicians have been radiographically confirming the fact that condyles undergo adaptive changes and are able to regenerate when compressive forces are removed and a homeostatic environment is established via stable neuromuscular occlusion (Figures 11 and 12).

Pancherez and Ruf and others [7, 8, 9, 10, 11] state that growth adaptation treatment with removable appliances is only successful during the main growth period around puberty. Whereas, fixed appliances can change mandibular growth to a clinical degree and make significant dental alveolar changes post-pubertal. These studies have shown that Class II malocclusion can be corrected with fixed appliances during growth period of the young and in adults. Temporomandibular joints reveal condylar and glenoid fossa remodeling and do not result in temporomandibular dysfunction on a long term basis. These results are now proving to be an alternative to orthognathic surgery.

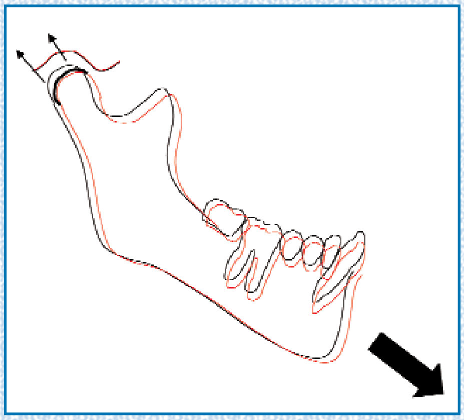

Figure 13: As the mandible moves down and forward, joint decompression allows homeostasis to occur within the glenoid fossa, resulting in an isotonic environment for condylar remodeling to occur..

Case Study

A 15 year old female presented with unfinished orthodontic treatment with accompanying head, neck and shoulder pain. A comprehensive examination was completed which included medical and dental history, intra/extra oral evaluation, orthopedic/TMJ musculoskeletal evaluation, radiographs which included: full mouth series (FMX), panoramic, lateral and AP cephalograms, submental vertex films, corrected cut tomograms (centric occlusion, rest, maximum opening), AP coronal views, lateral and AP cervical spine and paranasal views (Figure 16 and 17). A neuromuscular analysis included diagnostic study casts, computerized mandibular scanning (CMS – Scan 2, 3, 6, 13), electromyographic anaylsis (EMG before and after low frequency TENS – Scans 9, 10, 11) and electro-sonographic analysis (ESG – Scan 15, 16), and a computerized myocentric bite registration – Scan 4/5 with simultaneous EMGs (Figure 15) taken in a sitting up postural position without manual manipulation.[13] Diagnostic casts were mounted at Myocen-

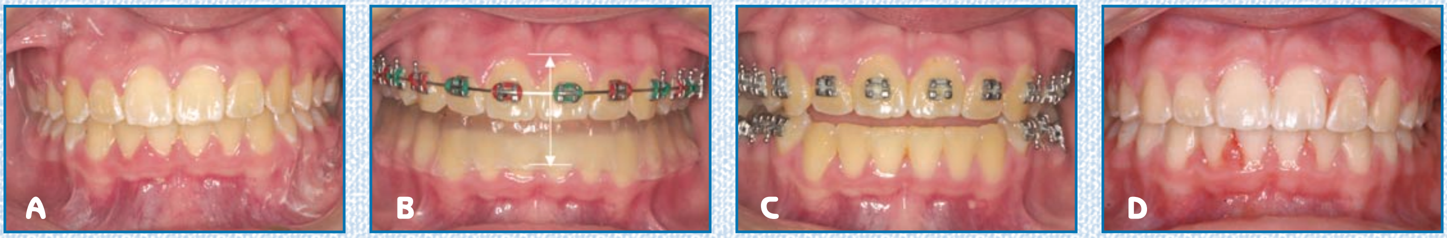

Figure 14: (a) Habitual occlusion before treatment, (b) start of orthodontics after mandibular stabilization with neuromuscular positioned orthotic, (c) bicuspids and first molars verticalized to the myocentric/neuromuscular position, and (d) finished orthodontic orthopedics to myocentric position.

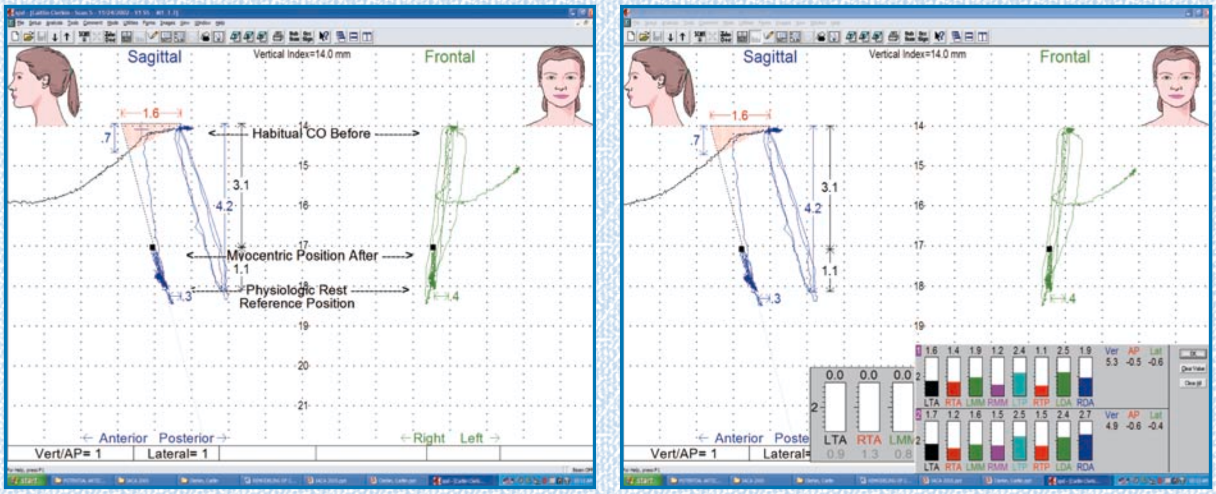

Figure 15: Computerized Mandibular Scanning and electromyography was used to assist in identifying a physiologic bite position prior to orthodontic/orthopedic movement of the teeth to the finishing myocentric position (Myotronics Kineseograph, K7, Tukwila, WA)

tric to fabricate a lower orthosis. Photographs were taken both extra oral and intra orally. Orthotic therapy was implemented for three months to established patient comfort and confirm a stable physiologic starting position before fixed mechanics were implemented (see figure 14).

Straight wire mechanics were used and the lower arch dentition was sequentially transitioned with verticalizing triangulating elastics via the orthotic position. The mandible was maintained throughout the treatment to the neuromuscular position by tripoding the mandible with first molar composite bonded blocks and an anterior night time removable acrylic overlay to the neuromuscular position. As the first and second bicupids were verticalized into occlusal contacts and the second molars self erupted into position, the first molar blocks were than removed. The lower anterior brackets were placed and bonded and a light round arch wire was ligated into position to assist in anteriorly verticalizing the cuspids and incisors to the final neuromuscular position. A series of straight wire finishing mechanics were implemented to complete the bite and occlusion.

Figure 16: Lateral cephalograms (above) and lateral cervical spine films (below) of a 15 year old female orthodontic patient. Note the improved lateral soft tissue profile and cervical alignment (improved lordosis) after neuromuscular orthodontic/orthopedics compared to before treatment (hyper-lordosis/forward head posture. As the mandible moves posteriorly, the cervical neck aligns (kyophotic). As the mandible moves anterior the cervical neck aligns (lordotic).

Figure 17: Note cranial and mandibular bone alignment as well as growth and development over a 22 months period of orthodontic/orthopedic treatment of the same 15 year old female patient.

Finishing records were taken which included radiographs, models, computerized mandibular scanning data (before and after TENS), electromyographic and electro-sonography and intra/extra oral photographs to confirm the treatment goals and objectives.

The patient reported that she no longer experiences any headaches, neck aches, shoulder aches, no joint noise, improved muscle function and is pleased with her bite. Total treatment was 22 months using both the removable orthotic therapy and finalizing the bite using both fixed straight wire mechanics established at the myocentric position.

Future Outlook

Today, one of the many keys to facial beauty and expression is maxillary arch form and development. Form follows function. Under-developed arches as well as malrelated mandibles to the cranium naturally leads to musculoskeletal compromises in both occlusal and postural stability. The dentist should recognize "abnormal posterior jaw closure patterns" that contribute to forward head postures, headaches, neck aches, shoulder aches and airway breathing compromises due to abnormal tongue posture.Narrow arch forms with V-shaped arches and vaulted palates result in many of the intra oral occlusal signs of wear, facets, crowding of teeth, lingual inclination of lower teeth, teeth chipping and cusp breakage with accompanying dry mouth syndrome and asymmetric faces. These problems if unrecognized and untreated will lead to unstable bites and lack of long term retention after orthodontic therapy. Orthodontic/orthopedic concepts are changing with the dental profession due to numerous clinical results and long term treatment outcomes that many general orthodontic practitioners and orthodontic specialists are experiencing in their clinical care.

The tongue needs proper oral volume for optimal function and oral pharyngeal patentcy. Sleep apnea, snoring, retrusive mandibles during sleep, disruptive sleep and breathing will result in less than optimal oxygenation to the human system. "The most significant principle to understand is that teeth seek a neutral position within a system of forces acting on them. The force system changes constantly during growth, and teeth move in response to stimuli in their environment. Clinical observation can, with experience, enable a dentist to assess the force system in a child or adult and determine whether the position of the teeth may improve or deteriorate when balance between the dentition and force system has been established."[12]

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