

Effect of the DNA Appliance™ on Migraine Headache: Case Report

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Abstract: *The relationship between migraine headaches and craniofacial architecture remains tenuous. Indeed, there is a lack of evidence linking migraines to orthodontic status. However, this case report may be one of the first to document the effect of a biomimetic, orthodontic appliance eliminating symptoms associated with migraine headaches.*

Keywords: *biomimetic; DNA appliance; migraine; headache.*

Introduction

The etiology of migraine headaches remains obscure. While evidence on an association between sleep bruxism, obstructive sleep apnea (OSA) and morning headaches is beginning to emerge, there is a dearth of evidence linking migraines to orthodontic status. In some cases, oral splint therapy and/or orthotics are used for the management of headaches, including those associated with temporomandibular dysfunction (TMD), but further studies on the relationship between orthodontic health and migraines are needed. The primary patho-etiology may be a state of hyper-responsiveness of the nervous system, but the molecular mechanisms are yet to be fully elucidated.¹

Despite the shortcomings in our understanding, patients with migraines are sometimes managed with oral splints and occlusal orthotics. For example, Didier et al.² studied patients with a diagnosis of chronic, daily headache using electromyography (EMG), kinesiography and masticatory muscle deprogramming by transcutaneous electro-neuro-stimulation (TENS). Their results indicated that patients with a significant discrepancy in jaw position had decreased frequency and intensity of migraine headaches when using an occlusal, neuromuscular orthotic. Similarly, Lamey and Barclay³ provided patients who had migraines with acrylic, occlusal splints for nocturnal wear. A good clinical response with considerable reduction in frequency and severity of pain was achieved. In addition, Wright et al.⁴ assessed the response of patients with a history of severe headache (tension-type, migraine without aura, and migraine with aura) to TMD stabilization appliances. After three months, the headache symptoms decreased by 39%, suggesting TMD appliance therapy can be beneficial for patients with severe headaches. Barnes et al.⁵ also evaluated the clinical procedures required to seat and adjust hard, heat-cured, acrylic, occlusal splints and an alternative appliance as part of migraine prevention therapy. More recently, Martins et al.⁶ investigated the knowledge and attitudes of dentists and orthodontists in the diagnosis and management of migraine. Eighty-two (51%) of orthodontists surveyed suggested orthodontic treatment with or without orthognathic surgery for the management of migraine, and some suggested using stabilization appliances prior to orthodontic treatment. However, to the best of our knowledge,

there are no reports in the medical, orthodontic or dental literature on the management of migraines with orthodontic therapy. Therefore, the aim of this case report is to document the preliminary effects of the DNA appliance™ (BioModeling Solutions, LLC, Beaverton, OR; Figure 1)⁷⁻⁸ on migraine headache therapy.

History

A 24-year old female presented in the dental office with a chief complaint of excessive daytime headaches. She had migraines for 'half her life' and her current chief complaint was episodes of migraines for about 2 weeks, since the orthotic that was being used had been partially sectioned. Her medical history was otherwise unremarkable.

Facial photographic analysis

This examination revealed mild facial asymmetry, with the lateral canthus of the eye above the medial canthus on both



Figure 1 - The DNA appliance system consists of a family of biomimetic appliances with different designs that all have patented 3D axial springs as an integral component. The example shown below is an upper acrylic-based DNA appliance similar to the one used in this case report.



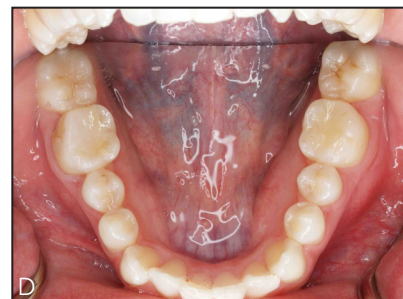
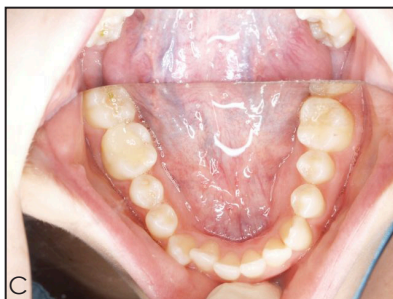
Figure 2 - Photographic analysis revealed mild facial asymmetry, with the lateral canthus above the medial canthus on both sides, producing an intercanthal angle of -4° . The ears were asymmetrical in the frontal plane with a rotational angle of -1° from the horizontal plane.



Figure 3 - Photographic analysis of the lateral profile revealed a frontonasal angle of 161° ; a nasolabial angle of 105° ; a labiomental angle of 159° , and a thyromandibular angle of 146° .



Figure 4 - The intra-oral findings revealed the upper arch (Fig. 4a) was tapered in shape, and the minimum intramolar width was approximately 29.5 mm. Figure 4b shows the same arch post-treatment.



The lower arch (Figure 4c) was crowded and asymmetrical in form. A unilateral mandibular torus was present on the right side, and minor tooth wear in the incisor region was detected. Figure 4d shows the same arch after initial DNA appliance therapy.



For the anterior occlusion (Figure 4e), there was a mild midline shift. In addition, the left and right maxillary molars appeared to be buccally positioned. There was a mild increase in overbite, but there was a Class I occlusion in the molar regions on both sides.

sides, producing an intercanthal angle of -4° . There was no sclera visible below the iris on either sides but poor lower eyelid support was noted on the left side, with mild venous pooling on both sides. The ears were asymmetrical in the frontal plane with a rotational angle of -1° from the horizontal plane. There was mild nasal asymmetry with shallow/flat infraorbital regions on both sides. Underdevelopment of the upper lip was noted on both sides, especially the on right, but there was no submandibular pannus under the chin (Figure 2). The frontal smile revealed fair smile esthetics with vestibular spaces ('buccal corridors') on both sides. In lateral profile (Figure 3), a mild, counterclockwise rotation of the forehead was found. The patient had a straight facial profile. The anterior cranial base appeared to be shortened with an increased frontonasal angle of 161° . The nasolabial angle was fair (105°) but deficiency at soft-tissue A point was noted, and deep nasolabial grooves were also found. The labiomental angle was increased (159°), suggesting an underlying skeletal Class III tendency. The lower border of mandible was poorly defined, and a mild submandibular pannus was detected. The thyromandibular angle was increased (146°), suggesting an increased likelihood of mild to moderate OSA.

Intra-oral photographic findings

The upper arch (Figure 4a) showed the archform was tapered in shape, with a bulbous appearance of the postero-lateral palatal regions. An occlusal 'step' between first and second molars on both sides was noted. Minimal tooth wear was present, and the minimum intramolar width (measured between the mesio-palatal cusps at cervical margin) was approximately 29.5mm. The lower arch (Figure 4c) was crowded and asymmetrical in form. A unilateral mandibular torus was present on the right side, and minor tooth wear in the incisor region was discernible. Anteriorly, in centric occlusion, there was a mild midline shift (Figure 4e). In addition, the left and right maxillary molars appeared to be buccally positioned. There was a mild increase in overbite, but there was a dental Class I occlusion in the molar regions on both sides.

Radiographic Findings

Lateral cephalometric

The cervical vertebrae alignment was straight/hypolordotic but the atlas-occipital distance was not visible (Figure 5). There appeared to be a good retroglossal airway space. However, a double lower border of mandible was noted, which might indicate asymmetric loss of ramus height; and antegonial notching of the lower border of the mandible was also detected. Thus, a differential

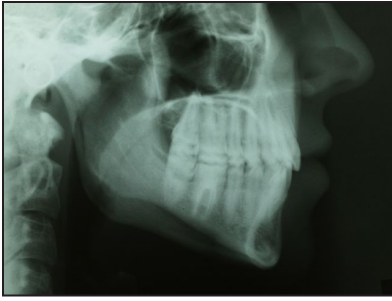


Figure 5 - In the lateral cephalometric radiograph, the cervical vertebrae alignment was straight/hypolordotic. The retroglossal airway space appeared to be good, but antegonial notching of the lower border of the mandible was detected

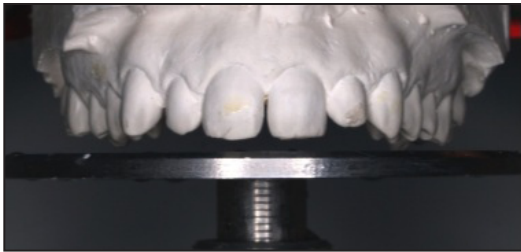


Figure 6 - The study models appear to show a cant in occlusal plane, and the left maxillary second molars appeared to be buccally positioned. The HIP mounting technique indicates a roll to the left and, therefore, 'torqueing' of the temporo-mandibular joints (TMJs).



Figure 7 - On articulation, there was a Class I occlusion in the molar region on the right side, and a Class II malocclusion in the molar region on the left side. The HIP mounting technique indicates the mandible is retruded in habitual occlusion.

diagnosis of internal derangement of TMJ/bruxing tendency was suspected.

Panoral

All permanent teeth were present and erupted; however, the upper and lower right and left third molars were missing.

Frontal cephalometric

This radiograph revealed a deviated nasal septum. In addition, relative hypertrophy of the inferior conchae on both sides was found. As nasal

obstruction was suspected, functional studies of airflow resistance might have been useful in this case, but none were available in this particular study.

TMJ Tomographs

The right condyle appeared to be retropositioned within the glenoid fossa and there was some evidence of "beaking" (thus anterior disk displacement was suspected). On the left side, the condyle appeared to be retropositioned within the glenoid fossa and there was evidence of mild beaking. Beaking can be a sign of degenerative osteoarthritis subsequent to a long term disk displacement. This association could lead to a differential diagnosis of temporo-mandibular dysfunction (TMD) syndrome. However, it is important to note that a medical diagnosis of migraine had already been confirmed by medical specialists in this case.

Study models

The hamular-incisive papilla (HIP) mounting of study models was used to determine the roll, pitch and yaw of the maxilla in this case. There appeared to be a cant in occlusal plane, and the left maxillary second molars appeared to be buccally positioned (Figure 6). On articulation, there was a Class I occlusion in the molar region on the right side, and a Class II malocclusion in the molar region on the left side (Figure 7). The cant of the occlusal plane could be related to the asymmetric ramal heights noted earlier, as well as the Class I/Class II molar relationship and the patient's facial distortion. These signs lead to diagnosis formulation.

Diagnosis

A dental diagnosis of Class I malocclusion (with underdeveloped midface and Class III tendency) was reached. The lower arch exhibited developmental compensation. Differential diagnoses of TMD, upper airway resistance syndrome (UARS) and/or obstructive sleep apnea (OSA) were also noted.

Treatment objectives

It was decided to remodel the upper arch (through midfacial development) to promote nasal breathing. This procedure would increase the upper minimum intramolar width to accommodate the tongue. It was decided also to resolve the lower anterior crowding. The treatment time for appliance therapy was estimated to be: 6-9 months for the upper arch; 6-9 months for the lower arch, and a further 3-6 months for arch re-coordination.

Treatment

An overnight sleep study was suggested to rule out OSA, and an ENT evaluation was suggested to evaluate the severity of nasal obstruction. An upper DNA appliance with 3-D axial springs on the anterior teeth was chosen, followed later by a lower, acrylic-based DNA appliance (Figure 1). This appliance therapy was followed by a phase of orthodontic treatment, starting with 016 NiTi wire, progressing to 18 X 25 NiTi wire, and finally finishing with 19 X 25 NiTi wire. In the fixed appliance therapy stage, elastics were used to verticalize the posterior teeth. Once the posteriors were closed, the brackets/wires were removed. A fixed lingual retainer was placed on the anterior 6 teeth to allow the posterior teeth to settle in to the occlusion and reach homeostasis.

Findings

The patient elected to not proceed with a sleep study. Figure 8 shows the case 12 months post-treatment with the minimum intramolar increased from approximately 29.5mm pre-treatment to approximately 35.5mm post-



Figure 8 - Intra-oral condition 12 months post-treatment (Figs. 8 a, b, c) with good dental alignment, and improved maxillo-mandibular morphology. The patient reported resolution of symptoms associated with migraine.

Figure 9 - The HIP mounting technique shows the neuromuscular position established after applying TENS to the muscles of mastication and facial expression for one hour. Note the forward and downward displacement of the mandibular dentition. This new mandibular position is consistent with the EMGs shown in Figure 10.

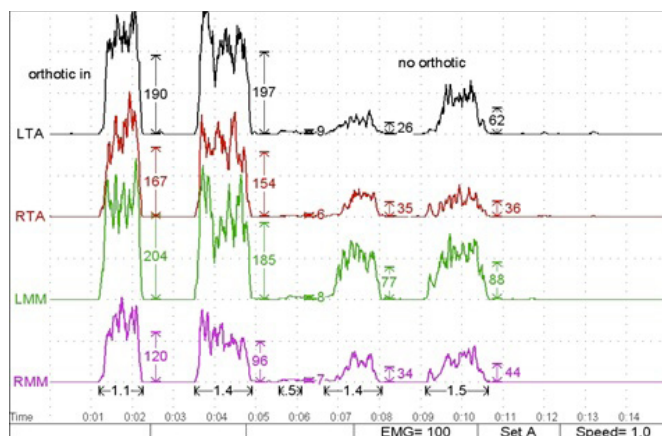


Figure 10 - EMG recordings. On habitual occlusion with no orthotic, the EMG recordings show little activity in the masseter and anterior temporalis muscles. With the removable orthotic in place, in the neuromuscular position, the EMG recordings show a higher level of activity of these muscles.

treatment; with good dental alignment and improved maxillo-mandibular morphology (Figures 4b and 4d). Moreover, the patient reported resolution of symptoms associated with migraine.

Discussion

The significance of this case should not be understated. This young and otherwise healthy lady had multiple, debilitating episodes of migraine for 11 years, virtually half her life. In that time she had visited several healthcare professionals who could only provide symptomatic relief with pain medications and, at times, hospitalization was required. Following a thorough medical/dental history, clinical examination of intraoral/extraoral tissues, radiographic examination, EMG and computerized mandibular scans, this patient was initially managed with EMG, kinesiology and TENS, in line with the suggestions of Didier et al.²

The hamular-incisive papilla (HIP) mounting of study models was invaluable in determining the roll, pitch and yaw of the maxilla in this case. This HIP mounting technique⁹ indicated a roll to the left (Figure 6) and, therefore, 'torqueing' of the temporo-mandibular joints (TMJs) had occurred as the mandible attempted to occlude with the putatively deformed maxilla. Conceivably, this deformation was associated with chronic inflammation of the tissues surrounding the TMJs, which in turn referred pain to the neck and shoulder. Additionally, the mandible was retruded in habitual occlusion (Figure 7). Alternatively, it could be suggested that torqueing of the mandible, as well as the maxillary deformity, were consequent to asymmetric condylar height. However, according to the principle of temporo-spatial patterning,¹⁰⁻¹¹ and the cranio-caudal gradient of human development, maxillary deformity implies mandibular developmental compensation, and not vice versa.

Figure 9 shows the neuromuscular position established after applying TENS to the muscles of mastication and facial expression for one hour. We found this position lay within a physiologic envelope that was able to place the mandible on the right path to eventual recovery (in conjunction with DNA appliance therapy). This new mandibular position was consistent with the EMGs shown in Figure 10. On habitual occlusion, the EMGs showed little activity expressed by the masseter and anterior temporalis muscles. It is reasonable to assume that the muscles were not functioning optimally when an imbalance in the occlusion was present, presumably precipitating chronic inflammation. With the removable orthotic in place, in the neuromuscular position, the EMGs showed significantly higher levels of activity of these muscles. Therefore, our results indicate this patient showed an initial improvement in migraine and headache symptoms when using a neuromuscular orthotic, but these symptoms recurred when the orthotic was sectioned, suggesting that the underlying patho-etiology had not been fully addressed. Therefore, in order to address the underlying maxillary deformity, an upper DNA appliance was worn for 8 months for approximately 12-14 hours a day. During this period of time, there was a complete absence of episodes of migraine. In addition, reoccurrence of symptoms when the orthotic had been sectioned indicates that the differential diagnosis of TMD is doubtful. The likely underlying cause of the migraine (maxillary deformity) was not fully addressed by the lower orthotic; hence the reoccurrence of symptoms on sectioning of the orthotic. In contrast, the DNA appliance addressed the chief (midfacial) concern, and conceivably was able to guide the craniofacial components on a developmental path to eventual recovery. Fixed orthodontic appliance therapy

was commenced while the DNA appliance was still being worn by the patient. The posterior occlusal coverage of the DNA appliance was sectionally removed, while the posterior teeth were verticalized with elastics. The DNA appliance was removed when the posterior teeth came into occlusion. The neuromuscular position was consistently monitored during appliance therapy until completion.

In summary, this case demonstrates that severe migraines can be treated conservatively without resorting to surgery. Thorough history, diagnosis and appropriate treatment planning resulted in resolution of a debilitating illness, improving the patient's quality of life immeasurably. The three phases of correction in this particular case can be summarized as; stabilization with a neuromuscular orthotic; midfacial correction with DNA appliance therapy and orthodontic finishing with fixed appliances. We conclude that it was the neuromuscular orthotic before it was sectioned, that eliminated the symptoms of migraine. However, it would not be prudent to subject a young patient to a lifetime of orthotic wear. Therefore, a DNA appliance was constructed to the initial neuromuscular bite registration. This DNA appliance appears to have been successful in remodeling the maxillary deformity (which was, presumably, the root of the problem) that permitted not symptomatic relief, but craniofacial correction, putatively eliminating the prime cause of the migraines. Indeed, in this particular case, the patient has now been asymptomatic for more than 6 months after the appliances were removed. Although a six month period of being pain-free may be a short term evaluation, this view needs to be balanced against a patient's experience of hospitalization, medication and recovery from a serious, debilitating illness. We will, therefore, continue to monitor this case for periodic review.

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