The Effect of Condyle Fossa Relationships on Head Posture

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ABSTRACT: Although it is commonly accepted that there is an interrelationship between the temporomandibular joint (TMJ) and head posture, few, if any, previous studies have quantified this effect. The purpose of this study is to quantify the effect of a change in the condyle fossa relationship of symptomatic temporomandibular joints on head posture. Charts of 51 patients (N=10 men and N=41 women) with symptomatic TMJ pathology were reviewed. The condyle fossa relationships were measured pre- and posttreatment using sagittal corrected hypocycloidal tomography. The amount of slant between the shoulder and external auditory meatus (EAM) was measured in pre- and posttreatment photographs as an indicator of forward head posture; less slant indicates better posture. Subjects ranged in age from 13-74 years (mean=43.1) and had been treated for an average of 5 months. Comparisons with pre-treatment measures showed that after treatment, the amount of retrodiskal space was significantly increased by an average of 1.67 mm on the left side ($t=-10.11$, $p<0.0001$) and 1.92 mm on the right ($t=-9.62$, $p<0.0001$). Comparisons also showed that after treatment, the amount of slant between the shoulder and EAM decreased by 4.43 inches on average which was also significant ($t=13.08$, $p<0.0001$). Improvement in the condyle fossa relationship was related to decreased forward head posture. This suggests that optimizing mandibular condyle position should be considered in the management of forward head posture (adaptive posture).

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The interrelationship of the temporomandibular joint (TMJ) and head posture is well documented in the scientific literature.[1-14] Stiwell,[7] in a paper published in 1927, may have been the first dentist to document the ascending and descending interrelationships of occlusion and posture. Since then, the *cervical triangle* (mandible, cervical spine, and hyoid bone) and its relationship to the mandibular rest position have been well documented by others: Thompson and Brodie[15] in 1942, Brodie[16] in 1950, Tallgren, et al.[4] in 1983, Fonder[17] in 1977, Darling, et al.[1] in l984, and Rocabado[18] in 1987. For instance, Thompson and Brodie[15] notes that the rest position of the mandible is the result of a combination of the posterior cervical muscles and the muscles anterior to the cervical spine.

Fonder[17] noted that malocclusion, of which TMJ disorder can be a symptom rather than a cause, can lead to imbalance of the neuromuscular systems involved in breathing, chewing, and swallowing. Tallgren, et al.[4] reported that the mandibular vertical dimension of rest (VDR) was found to be directly related to hyoid and head position. Darling, et al.,[1] in a study of eight patients, found that VDR increased with improved head posture after physical therapy. The possibility that dysfunctional relationships among the components of the cervical triangle can be modified using oral orthotics or manual cervical orthopedic techniques is also documented by Rocabado.[18] Bazzotti[2] related mandibular position and its effect on head posture to swallowing. Using electromyography and a kinesiograph to record muscle activity and mandibular position, he found a correlation between mandibular position and head posture. Loss of posterior occlusal support, unilaterally and bilaterally, is also shown to result not only in a change in mandibular position, but also in a change in head posture.[11,16] The connection between actual articular disk displacement and adaptive forward head posture is supported by Fink, Tschernitschek, and Stiesch-Scholz.[19]

Although the interrelationship between the TMJ and posture has been previously described, none of the previous studies attempted to quantify changes in the condyle fossa relationships and head posture. The purpose of the present study is to quantify the effect of change in condyle fossa relationship of symptomatic temporomandibular joints with changes in head posture.

Materials and Methods

Participants in this study consisted of 51 patients (10 men and 41 women) aged 13-74 years, who presented with various symptomatic TM disorders in a clinical practice in San Diego, California. TM disorders ranged from capsulitis with and without disk displacement to chronic degenerative osteoarthritis. To be included in this study, subjects were required to have both pre- and posttreatment tomograms, and pre-and posttreatment frontal and sagittal posture photographs.

All patients were treated with both day and night oral orthotics. Oral acrylic orthotics produced for the mandible were worn during the waking hours. The orthotics held a mandibular position that corrected for occlusal cant, vertical deficiencies, mandibular rotation and retrusion. This position was determined by neuromuscular concepts of phonetic speech and tomographic evaluation of condyle fossa relationships. Study models were mounted on an Accu-Liner articulator developed by James Carlson D.D.S.[20] (Accu-Liner Products, Woodinville, WA), which uses the base of the skull rather than traditional landmarks (condyle hinge axis) for mounting the maxillary model. Night appliances of various designs were produced depending on the type of TM dysfunction and parafunctional activities. Therapy for these patients consisted of conservative nonsurgical treatments.

Some patients received only orthotic therapy while others needed physical therapy to reach resolution of symptoms. One or a combination of several of the following therapies was used: iontophoresis, phonophoresis, trigger point injections, prolotherapy injections, moist heat, range-of-motion exercises, infra-red and pulsed radiofrequency. Of the 51 participants in the study, 36 were treated with only oral orthotics and conservative in-office therapies. Fifteen subjects were referred for chiropractic treatment, prolotherapy injections by an osteopathic physician, or both. Four additional subjects were referred to an osteopathic physician but declined the referral.

Postural photographs were taken at the beginning of treatment and again at maximum medical improvement. Therefore, only patients whose symptoms were relieved were included in this study, since they were the only group for which the pre-and posttreatment data, including postural photographs, were available.

Written informed consent was obtained prior to treatment from adult subjects and from a parent in the case of a minor-aged patient.

Bilateral sagittal hypocycloidal TMJ tomograms (corrected using a submentovertex x-ray) were taken in maximum habitual occlusion, at rest and at maximum opening positions (**Figure 1**). A one mm center cut of the condyle was used for all three positions. These x-rays, taken pre- and post-orthotic therapy, were performed on a CommCat D-2000 (Imaging Sciences, Hatfield, PA) which utilizes complex motion tomography. The image magnification is constant at 26%. A millimeter ruler calibrated for 26% magnification was used to measure the radiographs. The maximum habitual occlusal position was used to evaluate condyle fossa distances. The distance measured was from the posterior condyle surface to posterior fossa (tympanic plate) which was assessed bilaterally on both pre- and posttreatment radiographs.

Frontal and sagittal postural photographs were taken pre- and posttreatment with the patient standing behind a Symmetrigraf (Reedco Research, Geneva, NY). The patients were centered for the frontal photographs with the plumb line mid pelvis. In the sagittal photos, they were positioned with the plumb line centered on the shoulder (**Figure 2**). All photographs were taken with a tripod mounted Olympus C-2500L digital camera (Olympus America, Inc., Melville, NY) at a distance of eight feet. As suggested by Solow and Tallgren,[21] patients were instructed to relax with normal posture and to look straight ahead while being photographed.

These photographs were displayed on a laptop computer with a 13” screen. A standard millimeter ruler was used for measuring the digital photographs. A ratio of one inch on the Symmetrigraf to one mm on the monitor was

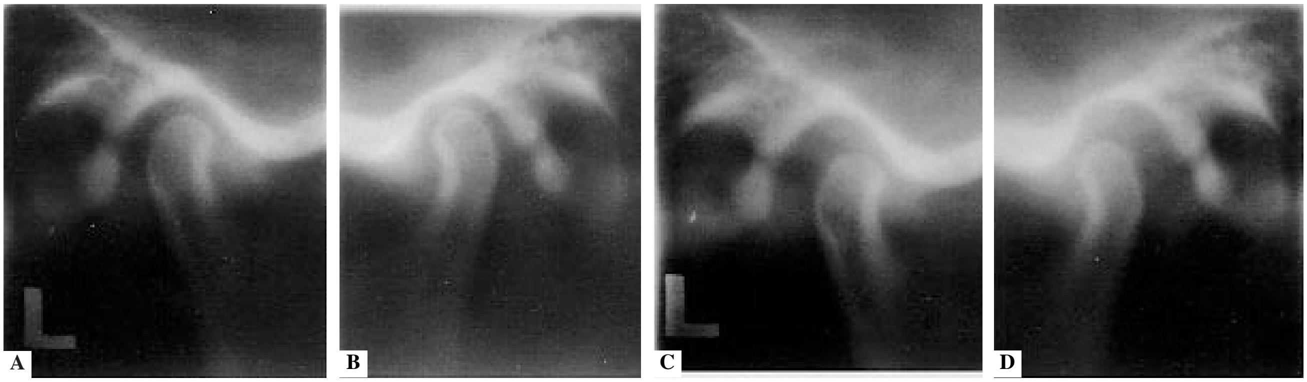

Figure 1
A: Before treatment (left); **B**. Before treatment (right); **C**: Orthotic position (left); **D**: Orthotic position (right).

found, allowing for the conversion to inches for calculations. Pre- and posttreatment forward head posture were assessed in photographs by measuring the distance between the shoulder and the external auditory meatus (EAM).

Statistical Analysis

Frequency distributions were calculated for all variables. Comparisons of mean pre-and posttreatment retrodiskal space, as assessed on the tomograms, and mean pre- and posttreatment forward head posture were performed using paired t-tests. The data were analyzed using Excel (Microsoft Corp., Redmond, WA) and an internet statistical program (VassarStats).[22] All tests were two-tailed with p<.05 considered significant.

Results

Among the 51 patients, ages ranged from 13-74 years with a mean age of 43.1 (±16.3). All patients had pretreatment tomograms and photographs between October 16, 2000 and September 4, 2002, and posttreatment tomograms and photographs between July 11, 2001 and November 25, 2002. The amount of time in treatment ranged from 44 to 405 days with an average of 146.8 days or about five months.

Table 1 shows the pre- and posttreatment distributions of retrodiskal space and shoulder-to-ear slant. Pre-treatment, retrodiskal space ranged from 1-5 mm with an average of 2.00 (±1.04) mm on the left, and from 0-4 mm with an average of 1.69 (±0.86) mm on the right. Pretreatment slant between the shoulder and EAM ranged from 1-17 inches with an average of 7.78 (±3.46) inches. After treatment, retrodiskal space ranged from 1-7 mm with an average of 3.67 (±1.37) mm on the left, and 1-8

Figure 2
A: Before treatment; **B**: After treatment.

Table 1
Distribution of Retrodiskal Space and Shoulder to External Auditory Meatus (EAM) Slant*

	Mean	Range
Pretreatment		
Left retrodiskal space (mm)	2.00	1 -5
Right retrodiskal space (mm)	1.69	0 - 4
Shoulder to EAM slant (in.)	7.78	1 - 17
Postreatment		
Left retrodiskal space (mm)	3.67	1 - 7
Right retrodiskal space (mm)	3.61	1 - 8
Shoulder to EAM slant (in.)	3.35	0 - 8
Pre- vs. Posttreatment differences		
Left retrodiskal space (mm)	1.67	0 - 5
Right retrodiskal space (mm)	1.92	0 - 7
Shoulder to EAM slant (in.)	-4.43	-1 to -13

* The shoulder to EAM slant indicates the amount of forward posture; the greater the slant, the more forward the head posture.

mm with an average of 3.61 (±1.50) mm on the right. Posttreatment slant between the shoulder and EAM ranged from 0-8 inches with an average of 3.35 (±1.82) inches. Calculating the differences between pre- and posttreatment measurements showed that on average, retrodiskal space increased by 1.67 (±1.18) mm on the left and 1.92 (±1.43) mm on the right. In contrast, the length of the slant between the shoulder and EAM demonstrating forward head posture decreased by an average of 4.43 (±2.42) inches.

Comparisons using paired t-tests (**Table 2**) demonstrated that posttreatment retrodiskal space was significantly larger than pretreatment retrodiskal space for both the left and right TMJ ($t=-10.11$, $p<0.0001$ on the left side and $t=-9.62$, $p<0.0001$ on the right side). **Table 2** also shows the mean posttreatment slant between the shoulder and EAM.

Discussion

The results of this study demonstrate that improvement in TMJ health is related to posture and shows the extent to which a change in the condyle fossa relationship can affect posture. While others, such as Zonnenberg, et al.,[9] show a relationship between treatment for TMJ disorder and posture, the current study is the first to quantify this association within the TMJ itself.

Kraus[23] stated that head-neck posture has the most immediate and long lasting effect on the mandibular rest position. In contrast, results of the present study suggest that improvement in the condyle fossa relationship within the TMJ leads to improved posture. This is not to say that the current study proves that forward head posture is always caused by condylar position. The possibility that forward head posture sometimes results in posterior displacement of the condyle and that, conversely, a condylar displacement can result in forward head posture must be considered.

According to Makofsky's "Sliding Cranium Theory,"[24] increases in forward head posture produce change in initial occlusal contacts by altering the position of the maxillary teeth relative to the mandibular teeth. As proposed, the cranium slides forward on the atlas in forward head position and the maxilla moves to an anterior position relative to the mandible. This results in initial tooth contact posterior to full intercuspation, forcing the mandible for-

Table 2
Comparisons of Mean Pre- and Posttreatment Retrodiskal Space and Shoulder to External Auditory Meatus (EAM) Slant*

	Pretreatment	Posttreatment	t-test	p value
Left retrodiskal space (mm)	2.00	3.67	-10.11	<.0001
Right retrodiskal space (mm)	1.69	3.61	-9.62	<.0001
Shoulder to EAM slant (in.)	7.78	3.35	13.08	<.0001

* The shoulder to EAM slant indicates the amount of forward posture; the greater the slant, the more forward the head posture.

ward to reach centric occlusion. Makofsky[25] describes a case in which a patient with anterior disk displacement was treated with a repositioning orthotic and was relieved of TMJ symptoms, as well as the forward head posture, but developed suboccipital pain. In another case, a patient was relieved of cervical dysfunction symptoms with physical therapy but subsequently developed facial pain. The mechanical and neurophysiological interrelationship of the somatic structures of the cervical-cranial-mandibular region is well established.[1-3,5,6,8,10-12,15,18,19,23-25] This suggests that treatment needs to address both TMJ and cervical regions. As noted previously, approximately 30% of the patients involved in the present study had concurrent chiropractic, physical therapy, and/or osteopathic treatment while the condyle fossa relationships were stabilized. It is essential to stabilize the condyle fossa relationships if the forward head posture is of TMJ origin. It should be recognized that nociception is one of several factors linking the TMJ to head-neck alignment.

In the present study, an increase in posterior joint space was related to a reduction of forward head cant for all patients treated. It is important to appreciate that there is a range in which this relationship will be beneficial. Post-treatment distances of 3.67 mm (left) and 3.61 mm (right) were obtained using neuromuscular techniques (phonetic bite) and tomography to center the condyles in their respective fossa. Pretreatment posterior joint spaces were ≤2.0 mm. The most likely mechanism was correction of distances that were less than normal (with nociceptive input) to those that did not produce nociception and therefore did not result in posture avoidance mechanisms (forward head posture).

The results of the current study suggest that the diagnosis of the structural origin of posture avoidance mechanisms is important for determining which system should be stabilized first. Strict adherence to a protocol that insists upon either the correction of head-neck dysfunction or oral orthotic therapy will not have universally beneficial results. The ascending vs. descending origins of dysfunction need to be evaluated in each individual.

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