# THE IMPACT OF POSTURAL CHANGES ON DENTAL OCCLUSION

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**ABSTRACT**

*Body and head posture have been areas of intense research over the last decade. Significant relationships between postural changes and craniomandibular phenomenon are well proven. This paper focuses on the impact of postural changes (head and body) on dental occlusion, function, growth and development. Many theories have attempted to explain the nature of such relationship. These theories are discussed in this paper, and its impacts on different dental and craniocervical aspects are outlined. Despite scientific evidence presented in the literature, postural changes are usually overlooked in clinical practices. An overview on this topic is important to enable clinicians to provide more precise clinical assessment and management.*

**Key Words:** *Head, Occlusion, Muscles, Posture.*

## INTRODUCTION

The relationship between head posture and the muscle contact position (initial tooth contact) is of great interest to all disciplines of dentistry concerned with the treatment of patients with cranio-facial pain as well as to those dentists who perform bite registration for full dentures, fixed prosthesis reconstruction, and orthodontic diagnosis.[1,2] The interactions between head musculature and dental occlusion has been well documented as early as 1950 when Brodie[3] found that the rest position of the mandible is determined by muscular equilibrium between muscles of mastication and posterior cervical muscle. Many planes have been evolved to assess the head posture. Camper's plane (1768) and Frankfort plane (1884) were among the first to be described.[4]

## HEAD POSTURE AND OCCLUSION

### a. Occlusal Contact and Malocclusion

According to the well-known work by Posselt[5], none of the border positions of the human mandible are affected by posture and a tracing of so called envelope of motion remains virtually the same at all head or body positions. In patients who received immediate complete dentures, Tallgren et al[6] determined that changes in the mandibular inclination due to reabsorption of the bone ridges were accompanied by changes in the craniocervical posture. Mohl[4] suggested that a change in head posture will alter the habitual closing path form rest position to maximum intercuspation. He also stated that "head posture is the condition that appears to have the most immediate effect upon postural rest position". With the use of wax registration, both Schwaz and Posselt[5] have shown that tooth contacts are different when a subject closes with head posture altered as compared to the head upright position.

To demonstrate the principle of head-neck backward bending causing a posterior muscle contact position (MCP) and forward bending causing and anterior MCP, one needs only to perform a simple test. While lightly tapping the teeth (2-3 taps per second) with the patient sitting or standing, one can easily detect a change in contact pattern as the head-neck is moved from neutral to backward bending and from neutral to forward bending.[7] Makodsky and Sexton[8] using a T-scan, recorded dental contacts of patients who had undergone a surgical fusion of the craniovertebral region which prevented them from making normal movements. The recording of the dental contacts that was obtained from these patients were different from those of the control group. Yamaguchi[9] demonstrated that the unstable forces induced by abnormal posture were correlated with the varieties of malocclusion.

In a study conducted by Adamidis and Spyropulos[10], the position and inclination of hyoid bone were evaluated. It showed that Class III patients had a more anterior position of the hyoid bone. Martensmeier (1992)[11] showed that before treatment nearly half of the Class I and Class II patients had a marked cervical lordosis, whereas Class III patients had abnormal kyphosis. Later on, Nobili and Adversi,[12] in a group of 50 patients, found that patients with Cl II exhibited an anteriorly displaced posture, while Class III malocclusion subjects exhibited a posteriorly displaced posture. The consensus of most studies[4,5,13] is that initial tooth contacts are more retruded when the head

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is positioned in backward bending, or when the subject is supine.[1,14-16] Ramfjord and Ash[17] stated that initial contact will depend on posture. To the contrary, there is no evidence that body position or head posture can alter such structural relationship as tooth position in maximum intercuspation[1,5,8,13,15] or the vertical dimension of occlusion.[18]

The correlation between class II occlusion and forward head posture is well established.[19] Rocabado et al[20] states that "there is a dynamic relationship between head posture and dental occlusion". It has been found that mandibular retrognathia is significantly associated with an extension of the head over the cervical spine, which is always present in forward head posture.[19] In 1981 Macrotte[21] discovered a direct relationship between head posture and dento-facial dimensions, observing that patients with a concave profile show a greater tendency to keep their heads bent towards the ground, whereas patients with a distal relationship and a convex profile tended to keep their heads upwards. Southard et al[22] discovered that the intensity of occlusal contacts in segments varied according to posture which was less significant in supine subjects than in standing subjects. Southard suggested that postural effect on contact intensity should be taken into consideration in fixed prosthesis or dental restorations.[12] Hellsing and Hagberg[23] examined the bite force relationship to head posture, reporting a sample mean of 271.6 Newton in natural head posture and 321.5 Newton with 20 degrees extension. Other studies showed no head posture relationship with bite force in children[24] and young adults.[25]

### b. Vertical Dimension

In 1980, Vig et al[26] showed adaptation in head posture to total nasal obstruction among other conditions. Total nasal obstruction is seen to facilitate a progressive extension of the head reaching a peak at one to one and one-half hours after the stimulus began. A jaw opening of 5 to 10 mm can facilitate a mean change of 4.3 degrees of extension at the end of one hour. Daly et al[27] demonstrated that an 8mm of jaw separation is in association with a statistically significant alteration of head posture. There is an extension of the head after one hour of bite opening in 90% of the subjects studied with a range varying from 0.3 to 9.0 degrees. Ayub et al[28] have observed the change in vertical dimension in an edentulous 48-year old female before and after the physical therapy correction of a forward head posture. The vertical dimension changed from 59mm to 66.5 mm after one month following physical therapy. This study supports the clinical observation of a decrease in the resting vertical dimension of the mandible with forward head posture. Root et al[29] studied the effect of an intraoral splint on head and neck posture. They found no significant changes in head and neck posture with an increase in vertical dimension of occlusion (VDO). However, the insertion time in this study was limited (8 minutes).[30] It was emphasized elsewhere that the vertical occlusal dimension and the mandibular position must be taken into account regarding the cervical spine.[31] Moya et al[32] when treating patients with spasm of the sternocleidomatoid and trapezius muscles by means of an occlusal splint of 4.0 to 5.5mm thickness, demonstrated that the increase of the vertical occlusal dimension generates a significant craniocervical extension and decrease of the lordosis in the cervical spine.

Salonen et al[31] found a significant relationship between head posture and physiological freeway space in complete denture patients. Goldstein et al,[33] by using kinesiograph, determined that the forward head position was accompanied by a change in the mandibular postural position (MPP) that manifested itself as a significant decrease of the physiological freeway space as a result of upward and backward displacement of the mandible.[19] However, another study[34] that examined 13 edentulous adults revealed no significance difference between preferred vertical dimension of occlusion when the subjects were sitting upright and when in supine position. Brill et al[35] discussed how mandibular rest position can be altered by changes in head position. When there is extension of the head on the cervical spine, the mandible moves away from the maxilla increasing the freeway space.

## BODY POSTURE AND OCCLUSION

The research on body position and occlusion is also worth noting. Robinson claimed to induce changes in the temporalis muscle firing sequences by placing a one and one-half inch object under the heel of one foot of studied subject.[4] In the supine position the MCP is consistently retruded.[1,14-16] According to McLean et al, mandibular position is affected by the position of the body in space through the activity of neuromuscular mechanisms.[15] Tripodakis et al[36] demonstrated that the location and reproducibility of centric occlusion were not affected by body posture or the insertion of the mandibular positioning device. But they showed that the location and reproducibility of NM were slightly affected by body posture and greatly affected by the insertion of the mandibular positioning device. In the supine position a more posterior NM was obtained. Another recent study by Perinetti[37] showed a correlation between postural changes and intercuspidation position. With a different testing method, Milani et al[38] also showed that altering dental occlusion by wearing an oral appliance could induce some fluctuations in dynamic postural attitude.

Bracco et al[39] using a digital platform in a group of 20 patients showed a relationship between body posture and mandibular position. All the subjects analyzed demonstrated variations in body posture as a consequence of alteration in mandibular position. They stated that the basis for the observed postural improvement observed in myocentric position are associated balanced muscles and not the different dental contacts. Bracco et al[40] using a computerized footboard, in a sample of 95 subjects, demonstrated that all subjects showed variations of body posture in the different mandibular positions. They found that the myocentric position improved postural balance on frontal plane with respect to the other jaw positions considered. However, Ferrario et al[41] studied the center of foot pressure in 30 women, and their results indicated that the modification of foot-center of pressure were not influenced by asymmetric malocclusion nor by different dental positions. Given the lower age of studied group (mean of 21 years), the lack of association achieved can be due to subjects' structural resiliency and extended functional adaptability.

## FUNCTIONAL ASPECTS OF POSTURE

Morphology, function, and posture were shown to be closely interrelated and influence each other.[9] It is well established that head-neck backward bending increases the electromyographic (EMG) activity of the masticatory elevator muscles, especially the temporalis muscle.[2,42,43] The possible mechanism for this includes tonic neck reflex,[43] role of gravity,[14,15] and body position.[8,15] Funakoshi and Fujita[42] determined that the craniocervical dorsoextension produced a greater muscular activity in temporal muscle and a moderate increase in the masseter muscle. The forward head position is characterized by a dorsoextension of the head together with the upper cervical spine ( C1-C3), accompanied by flexion of the lower cervical spine (C4-C7), whereby the cervical curvature is increased.[19, 42] Using finite element analysis, Motoyoshi et al44 showed that in case of backward inclined posture, the high level stresses were observed at the spinous processes of C6 and C7, while in case of forward inclined posture the stresses were at C4.

Boyd et al[2] demonstrated that cervical extension leads to increased muscle activity in anterior temporalis and decreased activity in middle masseter and anterior digastric. Cervical flexion, however, has been shown to decrease muscle activity in temporalis. Hairston et al45 showed that the lateral pterygoid musculature showed an almost linear increase in baseline myoelectric activity as the subject moved through the semireclined position into the fully reclined position. Their data demonstrated that the pterygoid musculature plays a vital role in preventing passive mandibular retrusion and would thus aid in maintaining mandibular postural relationships with the maxillae and temporal bones. Solow and Keriborg[46] presented a mechanism where the obstruction of the upper air way would lead to an increase in craniocervical angulation to ease breathing. Solow et al[47] showed that obstructed nasopharyngeal airways are usually seen in connection with a large craniocervical angle, a small mandibular dimensions, mandibular retrognathism, a large mandibular inclination, and retroclination of the upper incisors.

## POSTURE AND GROWTH/DEVELOPMENT

The head postured in a more forward position, would stretch the soft facial tissue layer covering the face and neck, especially the suprahyoid muscles.[48] The downward and backward strength component produced by the tension of the soft tissues on the mandible, would restrict or redirect the facial development into a more caudal direction in addition to retrusion of the mandible.[49,50] These changes are characterized by individuals with dolichofaical features, a Class II skeletal frame, and great divergence in their maxillary bases.[51,52] The adoption of FHP during the growth and development period of individuals can not only generate occlusal discrepancies and an altered neuromuscular activity, but also may cause heavy structural and functional disorders of the TMJ, all of which predisposes to develop craniomandibular dysfunction.[19] Kraus[53] reviewed the effect of head posture on the development of the mandible and concluded that a high correlation exists between an extended head-neck posture and the development of a retrognathic mandibular posture. Solow and Tallgren[54] could determine through a cross study using cephalometry, that the extension of the head on the cervical spine is associated with a significant mandibular retrusion. Later, they confirmed this finding by longitudinal studies[55,56] and found that the craniocervical extension correlates significantly with a facial growth pattern of vertical type. It becomes evident that the head posture deeply influences the facial growth direction. The craniocervical angulation determines an anterior and posterior rotational growth of the jaw, which in turn depends on the head showing ventroflexion or a dorsoextension respectively.[19]

## PROPOSED THEORIES ON POSTURE/OCCLUSION INTERACTION

The cervical spine presents a slight curvature that is concave in the back, also known as physiological lordosis. It follows that the posterior cervical muscles must have a constant muscular tonus to prevent the head from falling back. The head is able to be maintained in this position through different mechanisms.[19] These mechanisms include peripheral or central nervous system. Ocular system, proprioceptive system, and interceptors informing the airflow adequacy are all examples of peripheral systems.[19] When neuromuscular systems (peripheral and central) have fail to achieve and maintain a straight postural position, the craniocervical posture most commonly adopted by patients is forward head posture.[19] It is postulated that a tooth interference activates the periodontal mechanoreceptors, which are capable of changing the habitual closing pathway of the mandible into centric occlusion.[17,18] This is an attempt by the body to eliminate the interference. It is also possible, although not well researched, that activation of the periodontal mechanoreceptors is able to affect changes in head-neck muscle function and thereby produce changes in head posture.[29]

With the exception of practitioners of cranial manipulative therapy who assert that muscle contact position (MCP) can be altered by small intracranial movements of the maxilla and/or temporal bones,[57,58] theories on the influence of head posture on MCP deal exclusively with the changes in mandibular position.[2,4,5,8,13-15,42,43,53] Mohamed[1] states that neck dorsiflexion (backward bending) causes the mandible to move away from the maxilla with resultant retrusion/depression of the mandible, while in ventroflexion (forward bending) the opposite occurs. Other researchers attribute the influence of head-neck backward bending on the mandible i.e. downward and backward movement to increased inframandibular soft tissue tension (supra/ infrahyoid muscles and fascia). This retrusive force is one attempt to explain the posterior occlusal contacts observed with the head-neck backward bent.[4,5,13] Another theory linked the head-neck backward bending effect to the activity of temporalis muscle. As the head-neck adopt a backward posture, increased EMG activity illustrates the elevation forces that direct the mandible into retrusion position accounting for initial occlusal contact that is posterior to the intercuspal position.[7,53]

The sliding theory:[7] It suggests that changes in head posture are able to produce a change in MCP by altering the position of the maxillary teeth relative to the mandibular teeth. This theory applies only to a change in initial occlusal contacts and not to maximum intercuspation, which is a structural position and is therefore not affected by head posture.[1,5 8,13,15] To appreciate how maxillary occlusal position is altered by changes in head posture, a review of occipito-atlantal (O-A) joint arthrokinematics (intimate joint mechanics) and synovial joint mechanics is helpful.[8] Kapandji[59] states that in extension or backward bending of the cranium, the occipital condyles slide anteriorly on the lateral masses of the atlas (C-1). When a convex joint surface moves on a concave surface, the rotary movement or roll and the translatory movement or slide occur in opposite directions simultaneously.[60] When the occiput bends backward, the convex occipital condyles simultaneously slide anteriorly on the concave atlas, and vice versa.[7,59,61] Steindler[61] stated that the total excursion of the convex occipital condyles on the lateral masses of atlas is 10mm. This 10mm slide in the joint is associated with a total rotary range of motion of 24.5° with 21° in O-A backward bending and 3.5° in forward bending.[62] When the cranium slides forward on the atlas during backward bending the maxillary teeth also slide forward relative to the mandibular teeth. Consequently, the MCP shifts posterior to the intercuspal position.[63,64] However, as the teeth assume maximum intercuspation, the maxillary teeth will guide the mandible forward (through the cusp-fossa relationships). Ideally with the head in neutral, orthostatic posture[65] and the teeth free of interferences, MCP will be in direct alignment with the intercuspal position.[1,7,66] As the vertical dimension is increased with an intra oral appliance, as an example, the mandible will be displaced downward which in turn releases suprahyoid musculature. The hyoid bone, now free from its suspensory pull, drops back, reducing the pharyngeal airway.[30] To compensate for this, the head assumes a more extended posture which would move the hyoid bone passively forward by stretching the suprahyoid musculature thus maintaining the potency of the airway.[27] Kraus[53] in his book "TMJ Disorders" advises that "as VDO increases, the head is placed in an extended position thereby influencing the tonic neck reflex (TNR)". When the head balance is upset, the horizontal position of the head is first restored by vestibular action on the neck muscle. From such an extended position, the TNR, in conjunction with ocular and vestibular system, will attempt to bring the eyes level. The eyes may be brought level by the head adjusting to a more upright position or by the head adjusting to a greater forward head posture. Urbanowicz[30] believed that head and neck posture response to a change in VDO is dependent on the degree of cervical spine dysfunction already present in the individual. In case of mouth breathing (presence of adenoids as example), the mandible has to be lowered. This produces a decrease of the tension of the suprahyoid muscles. The hyoid bone is freed and is allowed to fall downward and backward, reducing the pharyngeal air passage. Consequently, the head has to assume a farther forward and more extended position to passively move the hyoid bone forward and upward by tensioning the suprahyoid musculatures.[19]

Clinical tests: One test is to compare the amount of cranial backward bending present with the TMJ in neutral and in retrusion. With a lateral radiograph, the space between the occiput and the posterior arch of atlas (A-O space) is measured in head-neck backward bending and then following passive mandibular retrusion. Head backward bending is essentially blocked if the mandible is retruded beforehand. This is because the cranium is unable to slide forward on the atlas secondary to a bony stop between the posterior temporal fossa and the posterior aspect of the mandibular condyle.[7] A second simple test[7] is to compare passive mandibular retrusion with the head first backward bent, then in neutral, and lastly in forward bending. With the head in backward bending, retrusion of the mandible is blocked as the condyle abuts the temporal bone, where in head forward bending, it is free to retrude even more so than in neutral. This is because of the increased posterior TMJ space created by a posterior slide of the cranium during forward bending.

## CLINICAL IMPLICATIONS AND CONCLUSIONS

The fatigue that TMJ patients so often complain of can be attributed, in part, to the effect of gravity on forward head posture, which causes an increase in forward tension creating a compressive force on soft tissues, apophyseal joints, and posterior surfaces of vertebral bodies with excessive lengthening of anterior neck flexors and tightening of neck extensors.[30] TMJ fatigue can been seen also in cases with shorting of suboccipital and suprahyoid muscles with subsequent elevation of the hyoid bone itself.[28] Urbanowicz[30] illustrated 10-points physical therapy plan for negating the postural effects of increasing vertical dimension and forward head posture. Usually, many patients experience a reduction of the TMD symptoms after an increase in the VDO. Dentists should be cognizant of the fact that the head and neck may not be able to adapt to even a minimum change in VDO if cervical spine dysfunction exists.[53]

Understanding the sliding cranium theory will help explain the link between temporomandibular joint dysfunction and the physical therapy effects in the management of TMD cases.[8] For example a case has been reported[8] about a patient with forward head posture (FHP) who received an anterior repositioning splint to manage an anterior TMJ disc displacement with reduction. The patient responded well to splint intervention, but developed suboccipital pain. Conversely, in a second scenario, a patient with head-neck dysfunction responded well to physical therapy procedures including a correction of FHP, but developed facial pain.[8] In the first case, as the splint repositioned the mandible anteriorly and inferiorly, the cranium also hypothetically attempted to a forward bend on the atlas. Provided that a patient has a long-standing FHP, as the cranium attempts to rotate in a forward direction (downward) and the occipital condyles backward, the patient will have a suboccipital pain due to the limited ability of the occipital condyles (joint capsule, musculature, connective tissue, etc.). In the second scenario, patients usually has a class II malocclusion.[67] Physical therapy in these cases aims to help the patient approaching an orthostatic head-neck posture,[64,65] in which the occipital condyles moved to a more posterior position on the atlas. Because of that, the maxillary teeth and temporal fossae also move posteriorly relative to the mandible. As a result, an anterior MCP is created (the lower dentition slides anteriorly) causing a pseudomalocclusion or interference pattern each time patient's teeth came into contact.[8] Over a period of time, the patient's adaptive potential is exceeded and symptoms of TMJ/facial pain ensued.[66]

Makofsky[8] recommended that repositioning therapy should await the correction of head-neck dysfunction. Once the head posture is corrected, or at least improved, then mandibular repositioning will be more easily tolerated by the patient and a more superior result obtained. It appears; therefore that physical therapist and dentist are dependent on each other for successful patient treatment.[30] Kondo and Aoba[68] based on a complex case report, stated that early occlusal improvement combined with orthopedic surgery of the neck muscles or physiotherapy to achieve muscular balance of the neck and masticatory muscles, was found to be effective. Thus, assessing and managing cases with TMD and myogenic cervical/ facial pain can be better dealt with a holistic approach where orofacial and cervical signs and symptoms are addressed and sequentially targeted. Whenever needed, involving physical therapist to the therapy team should render case stabilization with improved prognosis.

## SUMMARY

Head posture and dental occlusion are crosslinked structurally and functionally. Spanning from earlier stages of growth to daily body orientations, multiple theories illustrated such relationship through mechanical and sensory mechanisms with different applications. It is therefore beneficial to consider the interaction between occlusal relationship, cervical condition, and head posture/ musculature. Doing so is further emphasized in the management of cases with chronic orofacial pain, TMD, and advanced oral rehabilitation.

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