# Influence of cervical posture on mandibular movement

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The masticatory system, which includes the maxillae, the mandible, the teeth, the temporomandibular joints (TMJ), and all associated muscles, is directly related to the cervical spine. The neuromuscular influence of the cervical and masticatory regions actively participate in the functions of mandibular movement and cervical positioning.[1-4] Mandibular movement is dictated by the neuromuscular control of the masticatory muscles until initial tooth contact occurs. The tooth inclines then guide the jaw into the maximum intercuspal position.[5] Normal mandibular closure from rest position to maximum intercuspation (postural movement) is an anterior and vertical movement.[6] The purpose of this study is to document the effects of various cervical postures on the anterior and vertical components of mandibular movement.

## LITERATURE REVIEW

Many factors influence the masticatory muscles and affect the rest position and path of mandibular closure.[4-8] Current literature suggests occlusal abnormality as a possible cause of headaches,[9] TMJ dysfunction,[7] and facial pain patterns.[9] Unfortunately, the influence of the cervical spine on the masticatory structures is frequently ignored. The dentist should consider the relationship of the cervical spine when rest position and mandibular movement are evaluated. The physical therapist should also include the potential influences of the masticatory system when the structure and function of the cervical spine are assessed. When all the components that affect the mandible function in proper relationship, the masticatory system demonstrates maximum efficiency with a minimal expenditure of energy.[1] However, when the structure or function of part of this complex, such as cervical posture, is altered, the entire region may be affected.

Various investigators have tested the relationship between the cervical spine and the masticatory system. Cervical posture changes can affect the mandibular path of closure,[6] the mandibular rest position,[10] and masticatory muscle activity.[3,6,11] In addition, increased gravitational forces on the head appear to affect the masticatory muscles.[4,12] Neurologically, the cervical apophyseal joints can directly alter muscular activity about the jaw,[13] because increased masticatory electromyographic (EMG) levels are noted with cervical backward bending. From the cited literature it can be concluded that the position of the mandible and the EMG activity of the masticatory muscles are greatly affected by the posture of the head. Although the exact mechanism by which head position affects the movement of the mandible is not completely understood, proper head-neck positioning appears important to all phases of dentistry.

## RATIONALE

Previous studies examined only the relationship of the mandible to cervical forward bending and backward bending in the sagittal plane. Such a cervical position is not usually observed clinically. The abnormal postural attitude frequently adapted is that of the forward-head posture (FHP), which Kendall[14] defined as a slumped rounded back with hyperextension of the cervical spine (backward bending of the neck). This is an anterior head position relative to the normal weight-bearing axis of the spine, and can lead to increased gravitational forces on the head,[15] strain of the cervical ligamentous structures and apophyseal joints,[15,16] and increased stress on the cervical muscles.[17] The forward-head posture may alter the neuromuscular influences on the masticatory system.

This study tested the hypothesis that as normal subjects adopt cervical postures of various degrees of forward-head position, the mandibular path of closure will be altered. As the head assumes a more forward position, it is hypothesized that masticatory muscle activity will increase and cause increased posterior-superior forces on the mandible. Forward-head posture may, therefore, cause a decrease in the vertical excursion of mandibular closure and an increase in the anterior excursion of closure compared with closing distances in natural head posture. Straight neck posture (military posture) (MP) can affect the mandibular muscles in various ways; therefore, the direction of change could not be hypothesized. If the subject had normal cervical flexibility and could easily attain a straight posture, the masticatory muscles might become more relaxed and allow the mandible to drop down and

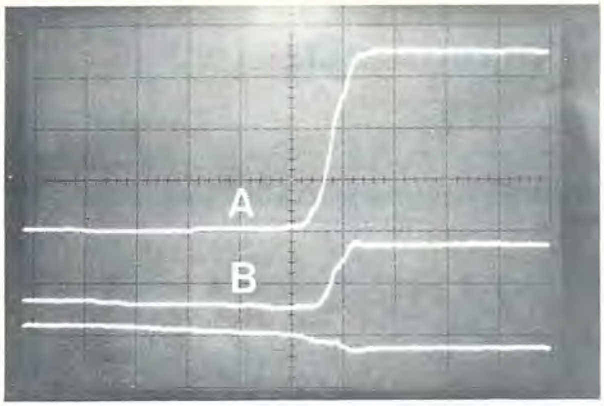


**Fig. 1.** Kinesiograph tracings of components of mandibular closure in natural posture (NP) for subject No. 5. Vertical distance of closure is 3.4 mm *(A)*. Anterior distance of closure is 1.2 mm *(B)*.


**Fig. 2.** Angle of head in natural posture *(NP)* for subject No. 5 is 52 degrees. Angle is measured between line drawn horizontally through C-7 and line from C-7 through tragus of ear.


**Fig. 3.** Angle of head in forward-head posture *(FHP)* of subject No. 5 is 34 degrees.

forward. Alternately, if increased muscular activity is needed to reach a straight position, the posterior and superior forces on the mandible may be increased.

## MATERIAL AND METHODS

### Subjects

A one-group pretest/posttest design was used to test the variability of the mandibular path of closure for temporarily adopted head postures in 12 normal subjects during a single session.[18] To limit the variables that can affect mandibular rest position and the path of closure, strict criteria were used to select subjects in this study.[19] To be included the subject needed to have (1) a full complement of at least 28 teeth (only third molars missing), (2) no extensive restorations, cast restorations, or cuspal coverages, (3) no history of orthodontic treatment, (4) no major occlusal abnormalities, and (4) no current TMJ symptoms such as joint pain on palpation, joint noises, or major deviations in mandibular movement. In addition, the selected subjects had (1) no history of severe head or neck trauma (fractures or severe whiplash injury), (2) no major abnormalities of the spinal curvature or postural alignment, (3) no current head and neck discomfort, and (4) no major restrictions of cervical segmental mobility. The subjects selected were seven women and five men with a mean age of 27.5 (SD 2.5) years. Many patients diagnosed to have head and neck dysfunction syndrome are found in this age range.[20]

### Kinesiograph

Vertical and anteroposterior components of the path of mandibular closure were analyzed with a mandibular kinesiograph (MKG) (model K-5AR, Myo-tronics Research, Inc., Seattle, Wash.). The electronic instrumentation of the MKG enables simultaneous tracing of both components of the closure path as the mandible moves freely through the interocclusal space.[21] Jankelson[21] demonstrated that this unit is accurate within 0.1 mm near the occlusal position.

Preparation of the kinesiograph for testing followed the manufacturer's procedures.[22] The gain set of 1 mm/division was used most often during the study. The sweep mode allowed three beams to move across the oscilloscope screen. Throughout the study multiple checks were performed to ensure that the top beam represented the vertical distance of mandibular movement and the center beam represented the anteroposterior movement. The lowest beam (not used in this study) indicated lateral deviations (Fig. 1). In each posture tested the beams were recentered on the screen as variability of the tracings was noted on the oscilloscope. For consistency all kinesiograph procedures were performed by the same person (W.B.W.). A Tektronic oscilloscope camera (Myo-tronics Research,

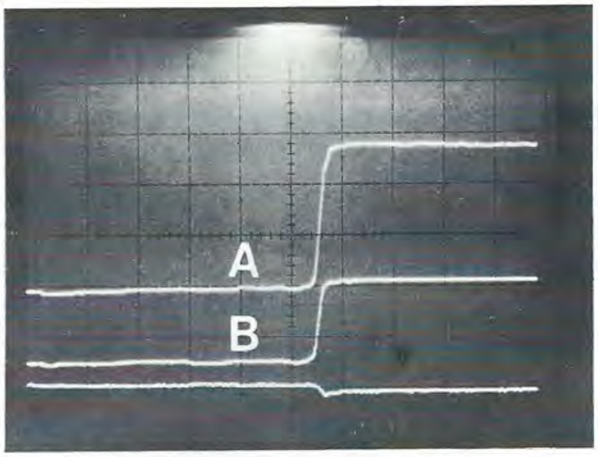


**Fig. 4.** Kinesiograph tracings of subject No. 5 in forward-head posture (FHP) show that vertical distance of closure is 2.8 mm *(A)* and anterior distance of closure is 1.6 mm *(B)*.


**Fig. 5.** Angle of head in maximal forward-head position *(MFH)* of subject No. 5 is 30 degrees.


**Fig. 6.** Angle of head of subject No. 5 in military posture *(MP)* is 59 degrees.

Inc.) was used to photograph the tracings from the oscilloscope after each posture was tested. The pictures permitted accurate measurement of the vertical and anteroposterior distance of mandibular movement through the interocclusal space. Ten percent of the measurements demonstrated agreement between raters with an interclass correlation coefficient *(r)* of 0.98, which was significant $p < .01$.[23]

## Postural evaluation

The postural position of the cervical spine was determined by the forward-head angle as described by Wickens and Kiphuth.[24] The forward-head angle was determined as the angle formed by a line drawn on a lateral photograph, perpendicular to a plumb line, that passed through the spinous process C-7 and a line that connected C-7 and the tragus of the ear (Fig. 2). Because the seventh cervical vertebra is considered relatively immovable with changes in head-neck posture,[25] a more pronounced forward-head position will demonstrate a smaller angle. Reliability of the measurements of head angle between raters was evaluated for 10% of the photographs. The interclass correlation coefficient *(r)* was 0.99, which is significant at $p < .01$.

In this study, four postural attitudes were tested. The subjects were asked to look directly into a mirror image of their eyes during each recording to minimize extraneous movement of the head in the sagittal plane, which might have affected mandibular movement.[10, 26]

## Data collection

Initially, the subject's postural movement (mandibular closure) while in the natural sitting posture (NP) was recorded with the MKG. Subsequently, the participant was instructed in the attainment of three additional cervical postures: (1) the FHP (Figs. 3 and 4), (2) the maximal forward-head posture (MFHP) (Fig. 5), and (3) the MP (Fig. 6). The FHP was chosen to duplicate a frequently observed postural attitude that requires minimal muscle activity. The MFP and MP provided measurements from the two extremes of active anteroposterior cervical motion. Directions were read to each subject by the same examiner (D.G.).

The mandibular rest position was recorded by means of the procedure described in the MKG literature.[22] Relaxation was evaluated by observation of the subject. The rest position was determined to be stable if the paths of the vertical and anterior beams did not vary more than 0.5 mm for 1½ passes across the screen (10 to 15 seconds). When the rest position was stable, the subject was asked to close the mandible and maintain firm tooth contact. The MKG beam was

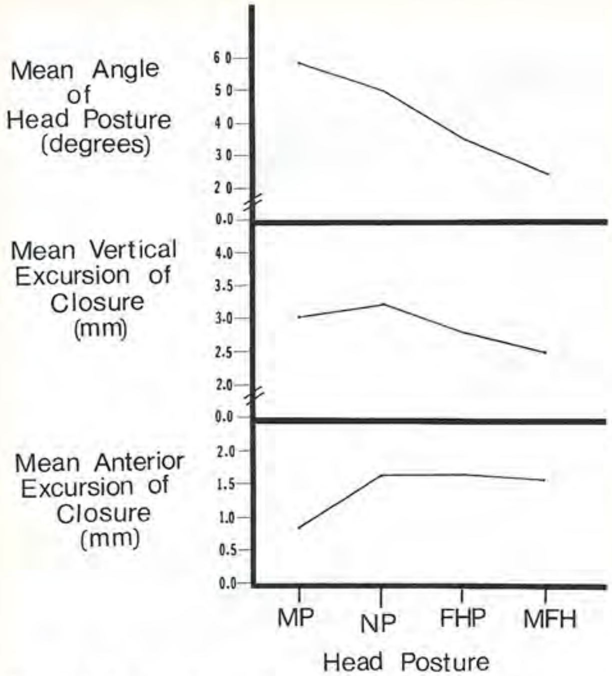


**Fig. 7.** Mean values of angle of head posture, mean vertical excursion of closure, and mean anterior excursion of closure are shown at four postural positions tested.

turned off and a photograph of the tracings was made. The subject completely relaxed between posture tests.

### Data analysis

The mean value of the vertical component and the mean value of the anterior component of the path of closure were tested for statistical significance ($\alpha = .05$). A one-tailed paired $t$ test was used to compare the vertical and anterior components of NP with FHP and MFHP.[18] A two-tailed $t$ test was used to compare differences between the NP and MP positions.

## RESULTS

The average forward-head angle in the NP for the 12 subjects tested was 49.9 degrees (SD 3.8 degrees) (Fig. 7). The mean distance of vertical mandibular closure was 3.2 mm (SD 2.1 mm) and the mean distance of anterior mandibular closure was 1.7 mm (SD 1.4 mm) (Fig. 7). When the subjects assumed the FHP, the angle of the head dropped to 34.6 degrees (SD 8.6 degrees). In this posture the mean distance of vertical mandibular closure was 2.8 mm (SD 2 mm) and the mean distance of anterior mandibular closure was 1.7 mm (SD 1.5 mm). Movement to the MFHP resulted in a head angle of 24.7 degrees (SD 7.4 degrees), a mean vertical distance of closure of 2.5 mm (SD 1.5 mm), and a mean anterior distance of closure of 1.6 mm (SD 1.3 mm). In the MFHP, one subject showed an increase in the head angle from the FHP, possibly caused by a misinterpretation of directions. This set of measurements was eliminated from the statistics to provide results for only 11 subjects at this posture. Adopting the MP produced a head angle of 58.2 degrees (SD 1.7 degrees) with a mean vertical distance of closure of 3 mm (SD 1.7 mm), and a mean anterior distance of closure of 0.82 mm (SD 0.6 mm).

The statistical significance of the vertical and anterior distance values for the various adopted postural positions was tested. Comparison of the vertical aspect of closure of NP with FHP demonstrated a significant decrease in the interocclusal distance ($t = -1.8$, $df = 11$, $p < .05$). The null hypothesis was rejected, because a substantial reduction in the vertical distance traveled from rest position to maximal intercuspation was evident. The anterior distance of mandibular closure, however, did not change significantly from NP to FHP ($p > .05$).

There was a significant decrease in the vertical distance of mandibular closure from NP to MFHP ($t = 1.83$, $df = 10$, $p < .05$). This comparison suggests that as the head is brought further forward the vertical interocclusal distance remains decreased from that at NP. Conversely, comparison of the anterior aspect of closure from NP to MFHP did not change significantly ($p > .05$).

There was no significant difference in the vertical measurement of closure from NP to MP ($p > .05$). There was, however, a significant decrease in the anterior distance of closure from NP to MP ($t = 3$, $df = 11$, $p < .025$).

## DISCUSSION

The results of this study demonstrate that a change in anteroposterior head position will alter at least one component of the path of mandibular closure as measured from the rest position to the maximal intercuspal position. As the components of closure are altered, the trajectory of the mandible into occlusion will also be changed. We believe that the adopted cervical postures may cause a change in the mandibular rest position, which was reflected by the observed change in the distance of closure. The rest position is determined by the "dynamic postural equilibrium" of all the forces about the mandible[4] and is considered the postural base from which all mandibular movement begins.[4,6] The results of this study suggest that changes in head position do affect the balance of forces on the mandible.

As the subjects assumed FHP, the vertical excursion of closure was decreased from that displayed at NP, which indicates that the mandible may not have dropped to the normal rest position. We speculate that

FHP affects the forces on the mandible by increasing the activity of masticatory muscles that pull the mandible upward. These muscles could be facilitated by increased effects of gravity,[4, 12] cervical backward bending that accompanies the FHP,[3, 6] or through compression of the cervical apophyseal joints.[13] Subjects with normal cervical flexibility could easily achieve a straightened posture (MP). In this position the vertical closure distance was unchanged from NP, which possibly indicates that there was no increase in upward forces on the mandible. In this posture, the mandible also assumed a more anterior position at rest, which may indicate a reduction of retrusive forces. Straightening the cervical posture may reduce superior and retrusive forces on the mandible and allow the mandible to seek an improved rest position.

The results differ from those observed by Prieskel,[6] who reported variations in rest position and the components of closure after cervical backward bending. He noted that this neck position caused increased inframandibular soft tissue tension, which pulled the mandible downward and backward. Mandibular closure, therefore, resulted in an increase in both the vertical and anterior distances of mandibular movement through the interocclusal space. Changing the head position in the sagittal plane only, as performed by Prieskel,[6] may result in different forces on the mandible than are found in the clinically observed FHP. The proper cervical position in both the anteroposterior and sagittal planes appears important to obtaining the optimal mandibular rest position.

The results of this study also substantiate Mohl's[8] contention that altered head posture will change the path of mandibular closure, which will cause abnormal initial tooth contact. The adopted head postures used in this study appeared to change mandibular closure, thus the trajectory of the mandible toward occlusion was altered. Occlusal abnormalities have been related to facial pain, headaches, and TMJ disorders.[7, 9] In addition, this study suggests that the postural position of the cervical spine may be an initial cause of some occlusal discrepancies and altered neuromuscular harmony.[7, 9] The results also appear to agree with those of Mintz,[5] who noted that "the TMJ syndrome can develop from an orthopedic postural problem that affects the muscles that are necessary to maintain good posture and good health."

Because FHP significantly decreases the vertical interocclusal distance, the postural position should be assessed when optimal posterior occlusal support is measured. Alternately, a patient with less than adequate posterior support may be predisposed to an FHP to achieve proper occlusion. Proper postural positioning is important, therefore, for interocclusal measurements and occlusal equilibration. We suggest that discomfort associated with joint and muscle dysfunction, as well as postural abnormalities of the cervical spine, be treated initially to eliminate abnormal influences from this region before permanent changes in the occlusion are made. In addition, patients should not be forced into a straighter posture that may cause increased muscle activity and neck pain if the patient lacks the cervical flexibility to adapt to the new posture.

This study demonstrated the effects of a temporary change in cervical position on mandibular movement. Further research will be necessary to delineate the effects of changes in the anterior and vertical aspects of mandibular closure in a patient population with chronic adopted postural changes.

Several implications for physical therapy are also noted from this study. The observed normal head angle, measured with the subject sitting, was within the normal range reported by Cureton.[27] The normal anteroposterior range of cervical spine mobility was also determined by the difference in head angle at the MFHP and the MP. Further research is needed to evaluate the cervical range of motion and postural positions of various age groups. The effects of therapeutic treatment of the cervical spine on the components of mandibular closure in a patient population should also be measured. We suggest that in future research the active cervical range of motion in the anteroposterior plane be considered as one criterion to determine normal cervical flexibility.

## CONCLUSION

Alterations of anteroposterior head and neck posture appear to have an immediate effect on the trajectory of mandibular closure in a normal population. As the head moves anteriorly relative to the normal weight-bearing axis of the spine, the vertical distance of mandibular closure significantly decreases. When the head moves posteriorly and the cervical spine is straightened, the anterior excursion of the mandible through the interocclusal space decreases. The findings of this study suggest that the influences of the cervical spine be considered when optimal results from dental procedures are sought.

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