# Head and Cervical Posture in Patients with Temporomandibular Disorders

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***Aim:*** *To determine whether patients with myogenous or mixed (ie, myogeneous plus arthrogeneous) temporomandibular disorders (TMD) had different head and cervical posture measured through angles commonly used in clinical research settings when compared to healthy individuals.* ***Methods:*** *One hundred fifty-four persons participated in this study. Of these, 50 subjects were healthy, 55 subjects had myogenous TMD, and 49 subjects had mixed TMD (ie, arthrogenous plus myogenous TMD). A lateral photograph was taken with the head in the self-balanced position. Four angles were measured in the photographs:* (1) *Eye-Tragus-Horizontal,* (2) *Tragus-C7-Horizontal,* (3) *Pogonion-Tragus-C7, and* (4) *Tragus-C7-Shoulder. Alcimagen software specially designed to measure angles was used in this study. All of the measurements were performed by a single trained rater, a dental specialist in orthodontics, blinded to each subject's group status.* ***Results:*** *The only angle that reached statistical significance among groups was the Eye-Tragus-Horizontal ($F = 3.03$, $P = .040$). Pairwise comparisons determined that a mean difference of 3.3 degrees (95% confidence intervals [CI]: 0.15, 6.41) existed when comparing subjects with myogenous TMD and healthy subjects ($P = .036$). Postural angles were not significantly related to neck disability, jaw disability, or pain intensity. Intrarater and interrater reliability of the measurements were excellent, with intraclass correlation coefficient (ICC) values ranging between 0.996–0.998.* ***Conclusion:*** *The only statistically significant difference in craniocervical posture between patients with myogenous TMD and healthy subjects was for the Eye-Tragus-Horizontal angle, indicating a more extended position of the head. However, the difference was very small (3.3 degrees) and was judged not to be clinically significant.* J OROFAC PAIN 2011;25:199–209

**Key words:** cervical posture, head posture, photographs, reliability, temporomandibular disorders

Cervical and head postures and their relation to musculoskeletal painful conditions such as neck pain and temporomandibular disorders (TMD) have been of interest to researchers and clinicians. It has been postulated that an altered posture of the head and neck might cause and/or predispose to painful conditions by altering the biomechanics and muscular balance of the craniocervical region.[1,2] It has also been postulated that the neck posture influences the mandibular[3–11] position and the muscular activity of the masticatory and neck muscles.[2,12] In addition, forward head posture, one of the most common alterations of the head/cervical posture, has been related to increased load in the cervical spine[1] and changes in the cervical soft tissues length and strength.[10]

Although the body of literature investigating these associations is steadily growing, a recent systematic review[13] investigating the relationship between head and cervical posture and TMD found no conclusive results regarding this relationship. Thus, the evidence is still questionable, and there are no definitive results supporting this connection. Most of the analyzed studies have lacked a clear clinical diagnosis to identify the condition, were low powered (ie, using small sample sizes), had inappropriate statistical analyses that impaired the accuracy of the results, did not report the reliability of the measurements, or the assessment was not blind. The systematic review also identified insufficient research investigating the association between head/cervical posture in subjects with myogenous TMD. Indeed, only two studies included subjects with myogenous TMD.

The present study was designed to determine whether patients with myogenous or mixed (ie, myogeneous plus arthrogeneous) TMD had different head and cervical posture measured through angles commonly used in clinical research settings when compared to healthy individuals.

## Materials and Methods

### Subjects

A sample of subjects who attended the TMD/Orofacial Pain Clinic at the School of Dentistry, Faculty of Medicine and Dentistry, University of Alberta, and healthy students and staff at the same institution were recruited for this study. Sample size calculation for this study was based on multivariate analysis of variance using the guidelines proposed by Stevens (using $\alpha = .05$, $\beta = .20$, power = 80%, and an effect size of 0.5).[14] Based on this calculation, approximately 50 subjects per group were needed to determine a difference in head and cervical posture measured through angles commonly used in clinical research settings among groups. Subjects signed an informed consent in accordance with the University of Alberta's policies on research using human subjects. This study was approved by the Committee of Ethics from the University of Alberta.

### Inclusion and Exclusion Criteria

*Healthy Subjects*. To be included in the study, healthy subjects had to be healthy females between the ages of 18 and 50 years[15] with no reported pain in the temporomandibular or neck region. Healthy subjects were excluded from the study if they had a history of chronic pain or clinical pathology or previous surgery related to the masticatory system or cervical spine or TMD symptoms for at least 1 year before commencing the study. Additional exclusion criteria were: abnormal range of movement (ROM) of the temporomandibular joint (TMJ) or cervical spine;[16] postural abnormalities of the craniocervical system and spine, such as scoliosis and hyperkyphosis;[17] central or peripheral neurological problems (such as radicular pain, stroke, or neuropathies) that could interfere with the experimental procedure and the outcomes; acute or chronic injury or systemic disease (such as acute pain, diabetes mellitus, or asthma); consumption of medications affecting the musculoskeletal system (such as anti-inflammatory or pain-relieving drugs, muscle relaxants, or arthritic medications); or if they were unreliable subjects (eg, mentally impaired).

*TMD Patients*. To be included in the study, subjects with TMD had to be females between 18 to 50 years of age; have pain in the masticatory muscles/TMJ for at least 3 months that was not attributable to recent acute trauma, active inflammatory cause, or previous infection; and have a moderate or severe baseline pain score of 30 mm or greater on a 100 mm visual analog scale (VAS).[18]

Subjects were diagnosed as having myogenous TMD based on classification Ia and Ib of the Research Diagnostic Criteria for TMD (RDC/TMD).[19] This diagnosis was based on clinical assessment following the guidelines proposed in the RDC/TMD,[19] although contrary to the RDC/TMD, subjects were required to have pain upon palpation in at least three of only 12 muscle points as proposed by Fricton et al[20–22]: temporalis (anterior, medial, and posterior belly) and masseter (deep belly, and the inferior and anterior portion of the superficial belly) bilaterally. Subjects with complaints of painful clicking, crepitation, or pain in the TMJ at rest or during function[23] and pain during the compression test[24] were excluded from this group and included in the mixed TMD group. Thus, the mixed TMD group included subjects complaining of muscular symptomatology (same as above) and articular symptomatology such as painful clicking, crepitation or pain in the TMJ at rest or during function,[23] and pain during the compression test.[24]

Subjects with TMD were excluded from this study if they had dental or periodontal disease, oral pathology lesions, oral infection, or neuropathic facial pain (as evaluated by a dentist from the TMD/Orofacial Pain Clinic of the Faculty of Medicine and

Dentistry at the University of Alberta), had a history of surgery of the craniomandibular system, evidence of neurological or bone disease, systemic disease, cancer, or were unreliable (eg, mentally impaired).

### Clinical Assessment

All participants (healthy subjects and patients with TMD) underwent a clinical examination by a physical therapist (the principal investigator) experienced in musculoskeletal rehabilitation and treatment of TMD to determine eligibility for this study and subject allocation (ie, myogenous TMD, mixed TMD, and healthy). Except for the number of palpated muscles sites (see above), the clinical examination followed the guidelines of the RDC/ TMD.[19] If the physical therapist felt the subject did not meet the inclusion criteria, the subject was excluded from the study.

## Instrumentation and Procedures

Demographic data were collected on all subjects who satisfied the inclusion criteria including age, weight, and height. In addition, all subjects were asked to report specific characteristics regarding their jaw problem such as onset, duration of symptoms, and treatments received.

### Pain Intensity

All patients with TMD were asked to report the average jaw pain intensity experienced in the last week on a 100-mm VAS, with the anchor points 0 "no pain" and 100 "worst pain imaginable." Subjects were to mark the scale to select their pain rating, and this was transformed into a numerical score (mm). The validity and reliability of the VAS for determining pain intensity has been reported and confirmed in the literature.[25–28]

### Neck Disability and Jaw Function/Disability

All subjects completed the Neck Disability Index (NDI)[29] and the Jaw Function Scale (LDF-TMDQ/JFS)[30] to evaluate the level of neck disability and jaw function/disability, respectively. Both measurements are considered valid and reliable for measuring disability of the neck and jaw.[29–31]

The Neck Disability Index is a relatively short questionnaire that measures how neck pain affects activities of daily living such as personal care, lifting, reading, headaches, concentration, work, driving, and sleeping. It is comprised of 10 items. Each of the 10 items was scored using a five-point numeric rating scale for a maximum total score of 50.[29]

The Jaw Function Scale (LDF-TMDQ/JFS) developed by Sugisaki et al[30] focuses on limitations of daily activities of patients with TMD. It is brief, multidimensional, and incorporates specific evaluations for TMD patients. It has 10 items, and each item was evaluated using a five-point numeric rating scale graded from 1 (no problem) to 5 (extremely difficult). The patients were asked to choose one of the five ratings on the scale in response to the following question: "how much does your present jaw problem prevent or limit your daily functions?" The total score summing the patients' answers was used for statistical purposes. The maximum total score was 50 points.

### Head Posture Photograph

A lateral photograph was taken with the head in the self-balanced position.[32,33] The self-balanced position was obtained with each subject standing with his/her visual axis horizontal relative to the floor, with no external intervention or modification of her posture.[32,33] The objective of this procedure was to obtain a position of the head and cervical spine in the sagittal plane that was determined by the subject's own postural system. The subject was asked to be shoeless, in standing position, with the eyes looking forward and with the teeth in occlusion. It was necessary to describe the position of the feet as "a comfortable distance apart and slightly diverging." Each patient was asked to breath in deeply (inhale), and then exhale normally, a process which was repeated until the patient felt comfortable and relaxed in a habitual posture (ie, without any external intervention). The patient was asked to maintain this self-balanced position without correcting it while the photograph was taken.

A digital camera (CANON PowerShot A570IS), positioned on a tripod at a distance of 183 cm from the subject, was used to take the photographs. The axis of the lens was placed perpendicular to the sagittal plane of the subject at a height that corresponded with the seventh cervical vertebra (C7). An anatomical marker was positioned on the skin overlying C7 and was fixed with double-sided medical tape. A free-hanging plumb line indicated the true vertical line on the photographs. Two photographs were taken for each individual, with approximately 1 minute between each photograph.

Alcimagen software (Instrumental Concept and Movement Analysis Laboratory, Uberlândia, Minas Gerais, Brazil) specially designed to measure angles and used in previous studies demonstrating excel-

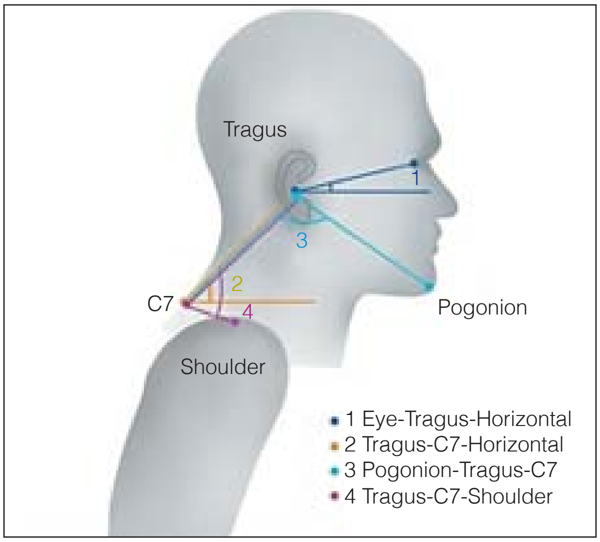


**Fig 1** Postural angles analyzed in this study.

lent intrarater reliability (intraclass correlation coefficients [ICC] = 0.99)[34,35] was used in this study to measure four angles in the photographs: *(1)* Eye-Tragus-Horizontal, *(2)* Tragus-C7-Horizontal, *(3)* Pogonion-Tragus-C7, and *(4)* Tragus-C7-Shoulder (Fig 1). The average of each of the measurements obtained from the two photographs was used for analysis.

These angles were chosen because they have been commonly used in other studies and in clinical research settings to evaluate the posture of the craniocervical region.[36–41] Thus, this study tried to mimic as closely as possible the clinical situation for evaluating head and neck posture. These angles have face and content validity to determine posture of the craniocervical region.[42]

The following guidelines were used to mark the anatomical points in the photographs and determine the angles (Fig 1):

1. Eye-Tragus-Horizontal angle: the angle formed by a line connecting the midpoint of the lateral corner of the eye with the Tragus of the ear (the cartilaginous protrusion in front of the ear hole) and a horizontal line;
2. Tragus-C7-Horizontal angle: the angle formed between the true horizontal and a line drawn from the midpoint of the Tragus of the ear to the skin overlying the tip of the spinous process of C7;
3. Pogonion-Tragus-C7 angle: the angle formed by a line connecting the pogonion (most forward-projecting point on the anterior surface of the chin) with the midpoint of the Tragus of the ear and a line connecting the skin overlying the tip of the spinous process of C7 with the midpoint of the Tragus of the ear;
4. Tragus-C7-Shoulder angle: the angle formed by the intersection between the upper middle point of the shoulder with the skin overlying the tip of the spinous process of C7 and the line connecting the Tragus of the ear with the skin overlying the tip of the spinous process of C7.

All the measurements were performed by a single trained rater, a dental specialist in orthodontics blinded to each subject's group status, following the same procedure for all photographs. For intrarater reliability, 30 randomly chosen photographs were measured in the same way at a second time at least 1 month later by the same trained rater, ie, the evaluator marked the anatomical landmarks for a second time in the photographs following the above guidelines and measured the angles again. A second rater (the principal investigator) measured 30 randomly chosen photographs to establish interrater reliability of the analyzed measurements (power for reliability analysis = 0.90, $\alpha = .05$ using ICC).[43,44]

## Statistical Analyses

The angles were analyzed descriptively (ie, mean, standard deviation) and explored for normality with histograms, Q-Q plots, and the Kolmogorov-Smirnov test. A one-way MANOVA test was used to analyze the difference between angles among groups. Paired comparisons using the Bonferroni post-hoc test evaluated the differences between angles among groups (objectives 1 and 2). The Spearman rho test was used to evaluate the association between postural variables, jaw disability, and pain intensity (objective 3). Multiple regression analysis was used to analyze the association between neck disability and head and neck posture angles (objective 3). The ICCs were calculated using a two-way mixed effects model and single measure reliability (ICC type [3, 1]) with absolute agreement, and alpha level set at 0.05 to evaluate the intrarater and interrater reliability of the measurements for all the analyzed angles following the guidelines of Shrout and Fleiss[45] (objective 4). In addition, the standard error of the measurement was calculated following the guidelines established by Weir.[46] The level of significance was set at $\alpha = .05$. SPSS version 17 (SPSS, IBM) and STATA version 10 statistical programs (StataCorp) were used to perform the statistical analysis. All the analyses were performed blind to group condition.

**Table 1 Demographic Data for the Three Groups**

| | Mean | SD | n |
|---|---|---|---|
| **Height (cm)** | | | |
| Mixed TMD | 166.30 | 5.89 | 49 |
| Healthy | 165.26 | 6.64 | 50 |
| Myogenous TMD | 162.04 | 19.66 | 55 |
| **Weight (kg)** | | | |
| Mixed TMD | 71.95* | 15.58 | 49 |
| Healthy | 64.02 | 12.35 | 50 |
| Myogenous TMD | 66.24 | 17.83 | 55 |
| **Age (years)** | | | |
| Mixed TMD | 30.88 | 8.19 | 49 |
| Healthy | 28.28 | 7.26 | 50 |
| Myogenous TMD | 31.91 | 9.15 | 55 |

*Significantly different when compared with healthy subjects at $\alpha$ = .05

**Table 2 Duration of Complaints, Pain Intensity, JFS Scores and NDI Scores for the Three Groups**

| | Mean | SD | n |
|---|---|---|---|
| **Duration of complaint (y)** | | | |
| Mixed TMD | 7.60* | 6.30 | 49 |
| Healthy | 0.00 | 0.00 | 50 |
| Myogenous TMD | 6.50* | 6.60 | 55 |
| **Pain Intensity (VAS, 0–100 mm)** | | | |
| Mixed TMD | 49.70* | 15.80 | 49 |
| Healthy | 0.00 | 0.00 | 50 |
| Myogenous TMD | 46.30* | 16.20 | 55 |
| **JFS Score (points, 10–50)** | | | |
| Mixed TMD | 22.78* | 7.05 | 49 |
| Healthy | 10.12 | 0.39 | 50 |
| Myogenous TMD | 19.13*† | 6.55 | 55 |
| **NDI (points, 0–50)** | | | |
| Mixed TMD | 13.02* | 6.99 | 49 |
| Healthy | 1.58 | 1.43 | 50 |
| Myogenous TMD | 10.75* | 5.67 | 55 |

*Significantly different when compared with healthy subjects at $\alpha$ = .05; †significantly different when compared with subjects with mixed TMD at $\alpha$ = .05.

## Results

### Subjects

A total of 172 subjects were assessed for inclusion in the study. Eighteen subjects were excluded: 9 subjects on the basis of not being totally healthy, 2 subjects being older than 50 years, 1 subject for having a neurological disease, 1 subject for having cancer, and 5 subjects for having a pain intensity lower than 30 mm on the VAS. One hundred and fifty-four participants provided data for this study. From these subjects, 50 were healthy, 55 had myogenous TMD, and 49 had mixed TMD. The demographics data are summarized in Table 1.

### Sample Characteristics

There were no significant differences among the three groups in age and height. Weight was significantly different between healthy subjects and subjects with mixed TMD (mean difference 7.9 kg [95% confidence intervals ((CI)) 0.38, 15.47], *P* = .036) but not significantly different between healthy subjects and subjects with myogenous TMD (*P* > .05).

Subjects with mixed TMD were similar to subjects with myogenous TMD in most of the clinical characteristics, such as pain intensity and duration of complaint. The average VAS pain intensity was moderate: 46.30 mm for patients with myogenous and 49.70 mm for those with mixed TMD (*P* > .05). Most of the patients had a long history of pain with an average of 6.50 years for subjects with myogenous TMD and 7.60 years for subjects with mixed TMD (*P* > .05) (Table 2).

Subjects with TMD presented with a mild level of disability in the neck and a moderate level of disability in the jaw. The maximum score for the NDI is 50. The subjects with mixed TMD had an average of 13.02 points, and the subjects with myogenous TMD had an average of 10.75 points. Both values are considered only mild neck disability.29 Related to the JFS, the maximum score is 50 points and the average of subjects with mixed TMD was 22.78 points and 19.13 points for subjects with myogenous TMD. The JDS but not the NDI was statistically significantly higher in subjects with mixed than myogenous TMD (mean difference for the JDI of 3.70 points, *P* = .003 [95%CI: 1.0, 6.3]; mean difference for the NDI of 2.30 points, *P* > .05 [95%CI: –0.352, 4.66]).

Table 3 Value of the Different Angles in Degrees for the Three Groups

| | Mean | SD | n |
|---|---|---|---|
| **Tragus-C7-Horizontal angle** | | | |
| Mixed TMD | 50.74 | 6.10 | 49 |
| Healthy | 52.46 | 5.11 | 50 |
| Myogenous TMD | 53.05 | 5.46 | 55 |
| **Eye-Tragus-Horizontal angle** | | | |
| Mixed TMD | 20.31 | 5.46 | 49 |
| Healthy | 18.79 | 5.64 | 50 |
| Myogenous TMD | 21.39 | 5.17 | 55 |
| **Pogonion-Tragus-C7 angle** | | | |
| Mixed TMD | 93.46 | 7.16 | 49 |
| Healthy | 90.11 | 6.63 | 50 |
| Myogenous TMD | 92.12 | 6.80 | 55 |
| **Tragus-C7-Shoulder angle** | | | |
| Mixed TMD | 90.99 | 13.40 | 49 |
| Healthy | 95.84 | 12.80 | 50 |
| Myogenous TMD | 94.62 | 13.36 | 55 |

### Postural Angles

The descriptive data for all postural variables can be found in Table 3. The MANOVA indicated that the angles differed significantly among groups (Wilks' Lambda = 272.0; $P < .05$). The univariate analysis showed that only the Eye-Tragus-Horizontal angle significantly differed (F = 3.03, $P = .040$), and only between myogenous TMD and healthy subjects (post-hoc pairwise analysis (mean difference of 3.28 degrees, $P = .036$) (Table 4). Patients with myogenous TMD had higher mean values for this angle compared with healthy subjects.

### Association between Postural Angles, Jaw Disability, and Neck Disability

The Pogonion-Tragus-C7 angle was statistically significantly, although weakly, associated with JFS and pain intensity ($r = 0.19$, $P = .018$ and $r = 0.22$, $P = .006$, respectively) (Table 5). The Eye-Tragus-Horizontal angle also was statistically significant but weakly associated with JFS ($r = 0.18$, $P = .030$). No other postural angle was significantly associated with jaw disability or with pain intensity (Table 5). The coefficients of variation ($R^2$) (0.036, 0.041, and 0.032 for the correlation between Pogonion-Tragus-C7 angle and JFS and pain intensity, and between Eye-Tragus-Horizontal angle and JFS, respectively) of these simple correlation coefficients indicate that postural angles explain only 3% to 4% of the variance of jaw disability and pain intensity. In other words, postural variables had no effect on jaw disability or pain intensity.

No individual angle was significantly correlated with neck disability measured through the NDI (Table 6). When the regression models for the postural angles were analyzed, only 12% ($R^2$) of the variance of the neck disability could be explained by the postural variables.

### Intra- and Interrater Reliability

Intrarater and interrater reliability was "excellent," with ICC values ranging from 0.993 to 0.998.[47] The standard errors of measurements (SEM) were also small, ranging from 0.31 to 1.99 degrees.

## Discussion

The main objective of this study was to determine whether patients with myogenous or mixed TMD had a different head and cervical posture than healthy individuals. The results indicated that the craniocervical posture as measured through the Eye-Tragus-Horizontal angle was statistically significantly different only between patients with myogenous TMD and healthy subjects. This indicates that an individual with myogenous TMD had a more extended head position (in the craniocervical region) than healthy subjects. However, and importantly, the difference between both groups was small (3.28 degrees) and therefore probably not clinically significant. Clinicians generally use clinical observation or, in some cases, photographs to evaluate posture.[48] It is unlikely that this assessment would allow consistent detection of such a small difference. Therefore, the clinical relevance of this result is questionable.

No other postural angle, such as Tragus-C7-Horizontal, Pogonion-Tragus-C7, or Tragus-C7-Shoulder, was statistically significantly different between myogenous and mixed TMD and healthy subjects, thus confirming previous findings.[49,50] These two previous studies are the only studies available which investigated head/cervical posture in subjects with myogenous TMD. They found no differences in head posture and cervical lordosis between patients with myogenous TMD and healthy controls. Visscher et al,[49] using the same angle analyzed in the present study, reported a value for the Tragus-C7-Horizontal angle of 52.3 ± 4.5 degrees for healthy subjects and of 52.7 ± 5.7 degrees for subjects with myogenous TMD, similar to those found in the present study (52.46 ± 5.11 degrees for healthy subjects and 53.05 ± 5.46 degrees for subjects with myoge-

Table 4 Pairwise Comparisons of the Different Angles in Degrees Among the Three Groups

| Dependent variable/ group | Mean difference | SE | $P^*$ | 95% CI for difference* Lower bound | 95% CI for difference* Upper bound |
|---|---|---|---|---|---|
| **Tragus-C7-Horizontal angle** | | | | | |
| **Mixed TMD** | | | | | |
| Healthy | –2.18 | 1.32 | .307 | –5.39 | 1.03 |
| Myogenous TMD | –2.03 | 1.248 | .320 | –5.05 | 1.0 |
| **Healthy** | | | | | |
| Myogenous TMD | 0.15 | 1.29 | 1.000 | –2.97 | 3.273 |
| **Eye-Tragus-Horizontal angle** | | | | | |
| **Mixed TMD** | | | | | |
| Healthy | 1.16 | 1.33 | 1.000 | –2.06 | 4.37 |
| Myogenous TMD | –2.13 | 1.25 | .274 | –5.16 | 0.904 |
| **Healthy** | | | | | |
| Myogenous TMD | –3.28† | 1.29 | .036 | –6.413 | –0.155 |
| **Pogonion-Tragus-C7 angle** | | | | | |
| **Mixed TMD** | | | | | |
| Healthy | 3.60 | 1.61 | .08 | –0.31 | 7.51 |
| Myogenous TMD | 1.04 | 1.52 | 1.00 | –2.64 | 4.72 |
| **Healthy** | | | | | |
| Myogenous TMD | –2.56 | 1.57 | .317 | –6.36 | 1.24 |
| **Tragus-C7-Shoulder angle** | | | | | |
| **Mixed TMD** | | | | | |
| Healthy | –6.07 | 3.06 | .15 | –13.50 | 1.36 |
| Myogenous TMD | –5.92 | 2.89 | .127 | –12.93 | 1.08 |
| **Healthy** | | | | | |
| Myogenous TMD | 0.14 | 2.98 | 1.000 | –7.09 | 7.38 |

Based on estimated marginal means; *adjustment for multiple comparisons: Bonferroni; †the mean difference is significant at the .05 level.

Table 5 Correlations between Jaw Function Scale (JFS) Score, Pain Intensity, and the Different Angles

| | JFS score | | | | Pain intensity | | | |
|---|---|---|---|---|---|---|---|---|
| | Correlation coefficient *R* | $R^2$ | *P* (two-tailed) | n | Correlation coefficient *R* | $R^2$ | *P* (two-tailed) | n |
| C7-Tragus-Horizontal angle | –0.005 | 0.000025 | .953 | 154 | –0.064 | 0.0041 | .432 | 154 |
| Eye-Tragus-Horizontal angle | 0.18* | 0.032 | .030 | 154 | 0.16 | 0.026 | .053 | 154 |
| Pogonion-Tragus-C7 angle | 0.19* | 0.036 | .018 | 154 | 0.22** | 0.041 | .006 | 154 |
| Tragus-C7-Shoulder angle | –0.11 | 0.012 | .179 | 154 | –0.01 | 0.0001 | .078 | 154 |

*Correlation significant at the .05 level; **correlation significant at the .01 level.

Table 6 Multiple Regression Analysis: Association between Neck Disability and the Different Angles

| NDI | Coefficient | SE | *t* | *P* > \|t\| | 95% CI | |
|---|---|---|---|---|---|---|
| Tragus-C7-Horizontal | 0.09 | 0.18 | 0.47 | 0.638 | –0.27 | 0.45 |
| Eye-Tragus-Horizontal | 0.08 | 0.16 | 0.47 | 0.640 | –0.25 | 0.40 |
| Pogonion-Tragus-C7 | 0.08 | 0.17 | 0.46 | 0.649 | –0.26 | 0.41 |
| Tragus-C7-Shoulder | –0.07 | 0.05 | –1.47 | 0.144 | –0.17 | 0.03 |
| Height | –0.03 | 0.11 | –0.28 | 0.784 | –0.24 | 0.18 |
| Weight | 0.06 | 0.04 | 1.33 | 0.186 | –0.03 | 0.14 |
| Age | 0.17 | 0.07 | 2.33 | 0.021 | 0.03 | 0.31 |
| Constant | –2.11 | 28.88 | –0.07 | 0.942 | –59.19 | 54.98 |

nous TMD); this indicates that there is consistency in these results across studies. Comparison with the results by Chiao et al[50] is impossible because they used a more general method of evaluating posture with no clear information of how they measured the head and cervical posture.

Since the present study investigated other variables not explored in previous reports, comparisons across studies are difficult. For example, the Eye-Tragus-Horizontal angle has not been used in the above-mentioned studies investigating posture in subjects with myogenous TMD, although it has been used to compare subjects with neck pain and healthy subjects. Silva et al[36] reported that healthy subjects presented a mean of 18.8 ± 7.70 degrees and subjects with neck pain of 21.0 ± 6.4 degrees. Harrison et al[51] reported similar results (controls, 18.8 ± 4.2 degrees and patients, 21.6 ± 6.4 degrees). The present results are in agreement with the results of both groups.

No significant differences in any of the postural angles were identified in the present study between subjects with mixed TMD and healthy subjects. This is not in agreement with the majority of the studies investigating the head/cervical posture in subjects with mixed TMD. Seven[52–58] out of nine studies analyzed in a recent systematic review[13] reported that patients with mixed TMD had an abnormal head and cervical posture compared to healthy controls (forward head posture). All of these studies were rated as methodologically weak, indicating that their results should be interpreted with caution. In addition, this systematic review[13] pointed out that the use of different definitions for TMD, different methods to measure posture (radiographs, photographs, and landmarks), as well as the poor experimental design, could have accounted for the difference in results, all factors that can also explain the difference in the results reported in the present study and those investigated in the systematic review.

From the studies using photographs[49,54,58] to analyze posture in patients with mixed TMD, two studies[54,58] found an association between head posture and patients with mixed TMD, while one study[49] did not support this conclusion. All of the three studies used the Tragus-C7-Horizontal angle. In addition, one of the studies used the Eye-Tragus-Horizontal angle,[54] and another used the C7-Shoulder-Horizontal angle.[58] The study by Visscher et al[49] was the only one that did not find any difference between the Tragus-C7-Horizontal angle between patients with mixed TMD and healthy subjects (52.8 ± 7.4 degrees for subjects with mixed TMD and 52.3 ± 4.5 degrees for control subjects). Although these results are in agreement with the results of the present study, Visscher et al[49] however used unequal sample size comparisons (45 controls and 15 patients with mixed TMD), so one may question whether these results could be found in a larger number of people with mixed TMD. Lee et al[54] and Braun,[58] on the other hand, found that the head posture measured through the Tragus-C7-Horizontal angle was smaller in patients with mixed TMD than in control subjects (51.4 ± 5.5 degrees for subjects with mixed TMD, 54.1 ± 4.5 degrees for control subjects, 48.2 ± 3.2 degrees for subjects with mixed TMD, and 55.4 ± 4.5 degrees for control subjects, respectively), indicating a more forward head posture in patients with mixed TMD than in healthy subjects. Both studies found a difference in this angle of about 2.7 degrees to 7.1 degrees. Further research is needed to determine whether these statistically significant differences are indeed clinically meaningful. As indicated by Falla et al,[59] subtle changes in head/cervical posture over time (about 4 degrees) could reflect poor muscle control of the deep cervical flexor muscles when sustained postures are evaluated in patients with pain in the upper quarter. Thus, as pointed out by Kraus,[60] a more functional evaluation such as a dynamic evaluation of the posture between patients with TMD and healthy controls could add to the understanding of the muscular impairments of these patients and also explain more accurately the symptomatology in these patients.

One interesting finding from another study performed by Visscher et al[61] was that healthy individuals showed a wide range of cervical spine postures (ie, lordotic, straight, or reversed cervical spine). This indicates that subjects even without a history of symptoms of the craniocervical region can present different postural patterns that cannot be considered pathological or predisposing to musculoskeletal pain. The present study also showed large postural variation in healthy subjects. The results by Visscher et al[61] could explain in part the results of this study. Healthy subjects presented similar angles to the group of patients. However, patients may have had less capacity to adapt and to support loads than healthy subjects and thus could develop pain. However, this capacity to adapt could be influenced by other factors (eg, psychological, physical, and social) not explored in this study. Future studies should utilize multifactorial models to explain more comprehensively the development of pain in conditions such as TMD.

The level of jaw and neck disability of the patients included in the present study was mild, even though the subjects with TMD had a long history of TMD pain. This could also explain in part the results obtained in this study, ie, that the level of disability was not great enough to have an impact on function or physical impairments generally found in subjects with pain. Further research on subjects with more severe disability levels and different types of TMD is needed.

Postural angles were not significantly related to neck disability when adjusted for age, height, and weight. When the regression models for these variables were analyzed, only 12% ($R^2$) of the variance could be explained by the postural angles. Even though jaw disability or intensity of pain had significant correlations with some of the postural angles, the magnitude of these relationships was very weak ($r = 0.18$, $r = 0.19$, and $r = 0.22$). In addition, the coefficients of variation ($R^2$) of these correlations indicated that these postural variables explain only 3% to 4% of the variance of jaw disability, which means that postural variables have no influence on jaw disability or pain intensity. This means that jaw disability is mostly explained by variables that were not accounted for in these models. The fact that postural variables were not related to pain intensity has been suggested by a recent study performed by Falla et al,[59] who found that improvements in forward head posture (ie, better ability to maintain upright position of the cervical spine) were not linked with a decrease in pain and disability in patients with neck pain. This fact points out that perhaps changes in pain and disability are more complex constructs that depend, as mentioned earlier, on different factors other than postural variables.

The present study used photographs and anatomical surface markers to evaluate posture. Even though this technique was found in this study to have excellent reliability for quantifying these postural angles, precise conclusions about the alignment of the cervical spine and head as shown in radiographs cannot be inferred. More research in this area to determine the validity and sensitivity of the angles measured on photographs is warranted.[48]

This study was designed to minimize bias regarding data collection and analysis. The study was strengthened by use of an adequate sample size for all groups of subjects, a clear clinical diagnosis to determine subjects' symtomatology, the use of a randomized order to analyze data, as well as a random selection of photographs for the reliability analysis, and blinding of the measurements.

## Conclusions

Craniocervical posture measured using the Eye-Tragus-Horizontal angle was statistically significantly different between patients with myogenous TMD when compared to healthy subjects. This indicates a more extended position of the head (craniocervical region) in this group of patients. However, the difference was very small and was judged not to be clinically significant. Postural angles were not significantly related to neck disability, jaw disability, and pain intensity.

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