J. Phys. Ther. Sci.
24: 601–603, 2012

Relationship between Symptoms of Temporomandibular Disorders and Upper Quadrant Posture: a Preliminary Study

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Abstract. [Purpose] The aim of this study was to investigate the relationship between symptoms of temporomandibular disorders (TMD) and upper quadrant posture measured by an ultrasound-based three-dimensional motion analyzer. [Subjects] The participants were 7 females with TMD symptoms (symptomatic group; mean age, 22.3 years) and 13 females without TMD symptoms (asymptomatic group; mean age, 23.3 years). [Methods] Outcome measures were the neck inclination angle (formed by a line connecting C7 and the ear tragus with a horizontal line), the angle of the shoulder (formed by a line connecting C7 and the acromial angle with a horizontal line), and the cranial rotation angle (formed by a line connecting the ear tragus and the corner of the eye with a horizontal line). The maximum range of mouth opening was measured using a scale. A significance level of 5% was used. [Results] The neck inclination angle of the symptomatic group was significantly smaller than that of the asymptomatic group in standing and in sitting. The maximum range of mouth opening of the symptomatic group was significantly smaller than that of the asymptomatic group. [Conclusion] TMD symptoms in young females were associated with head posture measured by an ultrasound-based three-dimensional motion analyzer.
Key words: Posture, Temporomandibular disorders, Ultrasound-based three dimension motion analyzer

(This article was submitted Feb. 7, 2012, and was accepted Feb. 22, 2012)

INTRODUCTION

Abnormal posture can cause musculoskeletal dysfunction. Abnormal upper quadrant posture can cause dysfunction of the neck, shoulder and upper extremity. Abnormal head or neck posture can also cause temporomandibular disorders (TMD). However, the relationship between TMD and posture is unclear. While some studies have shown that abnormal head posture, that is forward head posture, is associated with TMD[1–4)], other studies have reported that abnormal head posture is not associated with TMD[5–7)]. Olivo et al.[8)] suggested that the relationship between head and neck posture and TMD originating from the temporomanidibular joint (TMJ) and masticatory muscles was unclear. They also suggested that the controversial results obtained thus far are due to the different methods used to assess posture[8)]. Upper quadrant posture has been assessed using photographic images[1–3, 5–7)]. However, posture analysis based on photographic image has several limitations. The positional relationship between the subject and camera, the precision of the camera, and the identification accuracy of landmarks may affect the outcomes of posture analysis.

An ultrasound-based (US-based) three-dimensional (3D) motion analyzer is being used to investigate spinal range of motion. Cagnie et al.[9)] demonstrated that motion analysis using a US-based 3D motion analysis was able to record, calculate and display spatial head position, and was a significant breakthrough in measuring cervical motion. Other studies have demonstrated the high reliability of the US-based 3D motion analyzer for analysis of spinal range of motion[9, 10)]. This method can be also used for analysis of static posture based on the identification of easily defined landmarks. However, few reports have examined the relationship between TMD and posture measured by the US-based 3D motion analyzer.

The aim of this study was to investigate the relationship between TMD symptoms and upper quadrant posture measured by a US-based 3D motion analyzer.

SUBJECTS AND METHODS

The participants were 7 females who had experienced TMJ pain, masticatory muscle pain, or a limitation of mouth opening for at least 1 year before testing (symptomatic group; mean age, 22.3 years; age range, 20–33 years), and 13 females who had no experiences of these symptoms over the same period (asymptomatic group; mean age, 23.3 years; age range, 21–25 years). There were no participants who had consulted a doctor and received treatment for the TMD symptoms in the symptomatic group. Descriptive character-

Table 1. Descriptive characteristics of participants

	Symptomatic group (n = 7)	Asymptomatic group (n = 13)
Age (years)	23.3 (4.5)	22.3 (1.2)
Height (cm)	157.8 (7.3)	162.3 (4.8)
Weight (kg)	50.6 (3.2)	52.8 (4.9)

All data are expressed as mean (standard deviation).

istics of both groups are presented in Table 1. The Research Ethics Committee of Kio University approved the study and each participant provided their written informed consent to being involved in the study before it started.

Measurements of participants' posture were performed using the US-based 3D motion analyzer (CMS20S, Zebris, Germany). Posture analysis was performed in the standing and in sitting positions. For standing, the participants stood relaxed and faced the front. For sitting, they sat on a chair in a relaxed manner without a back rest with the feet flat on the ground, the arms hanging by the sides of the body, and facing the front. The participants were positioned approximately 1 m from the transmitter. Reference points were the eye edge, ear tragus, spinous process of C7 and the acromial angle. These reference points, except spinous process of C7, were identified on both sides. Identification of the reference points was performed by palpation. The reference points were marked by a pointer. The procedures were repeated in the order dictated by the system's software routine. Two measurements were performed in both the standing and sitting position, four measurements in total. Measurements in standing and in sitting were performed alternately.

The postural parameters we derived were the neck inclination angle (formed by a line connecting C7 and the ear tragus with a horizontal line)[1, 2, 11], the angle of the shoulder (formed by a line connecting C7 and the acromial angle with a horizontal line)[1, 2], and the cranial rotation angle (formed by a line connecting the ear tragus and the corner of the eye with a horizontal line)[11] (Fig. 1). These parameters were calculated on a display screen using the Win Spine program of the Zebris system. The mean values of both sides were calculated in each measurement because the status of adjacent tissues of the TMJ and movement of the TMJ are affected not only by the unilateral side, but also by the bilateral side of posture. The mean values of two measurements of each parameter were calculated. The maximum range of mouth opening was measured using a scale.

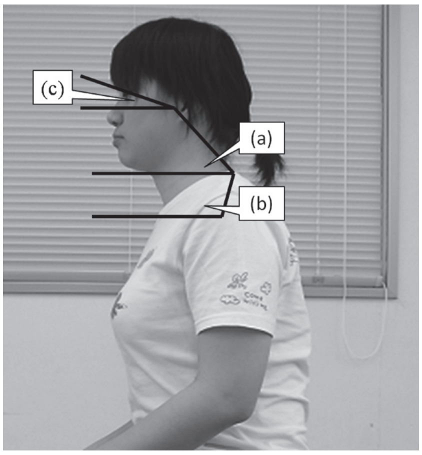

Fig. 1. Postural parameters
(a) Neck inclination angle, (b) Angle of shoulder, (c) Cranial rotation angle

Test-retest reliability of the US-based 3D motion analyzer was calculated for a separate group of 24 subjects by the same examiner using intraclass correlation coefficient (ICC[1.2]) on the same measurements. The range of ICCs was from 0.825 to 0.948, which is near perfect agreement based on the criterion of Landis and Koch[12].

Data were compared between the two groups using the unpaired t test. Significance was accepted at values of $p < 0.05$.

RESULTS

Age, height and weight were not significantly different between the two groups (Table 1). The neck inclination angle of the symptomatic group was significantly smaller than that of the asymptomatic group in standing (symptomatic group, 58.3 ± 5.5 degrees; asymptomatic group, 65.6 ± 7.3 degrees) and in sitting (53.2 ± 3.7 degrees; 63.7 ± 9.0 degrees, respectively). The maximum range of mouth opening of the symptomatic group (38.6 ± 8.1 mm) was significantly smaller than that of the asymptomatic group

Table 2. Postural parameters and range of mouth opening

		Symptomatic	Asymptomatic
Neck Inclination (degrees)	Standing	58.3 (5.5)*	65.6 (7.3)
	Sitting	53.2 (3.7)**	63.7 (9.0)
Angle of Shoulder (degrees)	Standing	126.4 (9.5)	122.1 (6.2)
	Sitting	125.3 (14.6)	123.1 (11.7)
Cranial Rotation (degrees)	Standing	14.6 (6.7)	17.2 (4.1)
	Sitting	15.9 (8.2)	18.7 (8.2)
Maximal range of mouth opening (mm)		38.6 (8.1)*	47.7 (4.7)

All data are expressed as mean (standard deviation). Symptomatic: Symptomatic group; Asymptomatic: Asymptomatic group. **$p<0.01$, *$p<0.05$

(47.7 ± 4.7 mm). Significant differences were not found for angle of shoulder or cranial rotation angle in both standing and sitting (Table 2).

DISCUSSION

The neck inclination angle of the symptomatic group was significantly smaller than that of the asymptomatic group both in standing and in sitting. This result suggests that the head posture of the symptomatic group presented more forward than that of the asymptomatic group. The maximum range of mouth opening of the symptomatic group was also significantly smaller than that of the asymptomatic group, suggesting that the range of mouth opening was restricted in the symptomatic group.

Head, neck and shoulder posture have been analyzed using photographic images, as stated above, and our results are consistent with the photographic results. Braun[1] reported that women with TMD symptoms showed a neck inclination angle of 48.2 ± 3.2 degrees, while those without TMD symptoms showed 55.4 ± 4.5 degrees in neck inclination. These outcomes were significantly different. Evcik et al.[2)] and Lee et al.[3)] also reported that neck inclination angles of TMD patients were significantly smaller than those of controls. In our study, the angle of the shoulder in the symptomatic group was 122.8 ± 19.2 degrees, while that in the asymptomatic group was in 112.9 ± 10.8 degrees. The difference was not significant between the groups. Therefore, our results demonstrate that a smaller neck inclination angle, that is, forward head posture, is associated with TMD symptoms.

The resting position of the mandible is affected by head posture[13, 14)]. In addition, the influence of head posture on the kinematics of the TMJ might relate to stretching and/or elongation of the opening and closing muscles of the TMJ and of other soft tissues that are attached to the mandible, with varying influence of the force of gravity on the mandible[14)]. Yamada et al.[15)] demonstrated increased activity of the temporal muscles when the head was bent backward that resulted in backward traction on the mandible during the closing movement and a closing path from the posterior direction. Therefore, forward head posture may give rise to abnormal mechanical stress on the TMJ and adjacent tissues, and influence the arthrokinematics of TMJ. These processes may result in TMJ pain.

Goldstein stated[13)] that increased masticatory electromyographic levels were noted with cervical backward bending. Boyd et al.[16)] found that cervical backward bending increased activity of the temporalis muscles. Backward rotation of the cranium resulted in anterior displacement of the maxilla relative to the mandible and anterior translation by the lateral pterygoid muscle to maintain occlusal support. These movements may lead to hyperactivity of the lateral pterygoid muscle, which may result in anterior displacement of the intra-articular disc. These processes may cause TMJ pain and masticatory muscle pain and restricted range of mouth opening.

There were several limitations to this study. The inclusion criteria were TMD symptoms of TMJ, masticatory muscle pain, or limitation of range of mouth opening. Patients diagnosed with TMD should be investigated in a future study. In addition, participants in this study were only young females and the sample size was small. Male patients should be included in a large sample size in a future study..

In conclusion, head posture of subjects with TMD was more anterior than that of subjects without TMD, and the range of mouth opening of TMD subjects was smaller than that of subjects without TMD. Thus, TMD symptoms in young females were associated with head posture measured by a US-based 3D motion analyzer.

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