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Original Article

Characteristics of Upper Quadrant Posture of Young Women with Temporomandibular Disorders

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Abstract. [Purpose] This study aimed to investigate the characteristics of upper quadrant posture of young women with temporomandibular disorders. [Subjects] The participants were 19 female patients with temporomandibular disorders (patient group: mean age, 30.1 years) and 14 controls (control group: mean age, 24.6 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), the cranial rotation angle (formed by a line connecting the ear tragus and the corner of the eye with a horizontal line), and the neck-length/shoulder-width ratio [the ratio of the neck length (from C7 to the tragus) to the width of the shoulder between the acromial angle]. The maximum range of mouth opening was measured using a scale. [Results] The neck inclination angle and maximum range of mouth opening were significantly smaller in the patient group than in the control group. No significant differences were observed in the other outcome measures between the two groups. [Conclusion] Temporomandibular disorders with limited mouth opening in young females are associated with the head position relative to the trunk.

Key words: Posture, Temporomandibular disorders, Ultrasound-based three-dimensional motion analyser

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INTRODUCTION

Temporomandibular disorders (TMDs) share the common feature of being significantly more prevalent in women than in men. The female:male prevalence ratio for TMDs is nearly 2:1 in the general population and can exceed 8:1 in clinical populations[1)]. Further, many authors have reported that the prevalence and severity of TMDs are increasing, especially in women of reproductive age[2–5)].

TMDs may be related to abnormal posture; however, various studies of this issue have reported conflicting results. Although some studies have shown that abnormal head posture (i.e. a forward head posture) is associated with TMDs[6–9)], other studies have not observed this association[10–12)]. Olivo et al.[13)] suggested that these controversial results are due to the methods used to assess posture. In many studies, upper quadrant posture has been assessed using photographic images[6–8, 10–12)]. However, posture analysis based on photographic images has several limitations, since the positional relationship between the subject and camera, the precision of the camera, and the accuracy of identifying landmarks may affect the outcomes. Hence, a more accurate method for assessing posture could help to resolve this current lack of clarification with respect to the association between TMDs and abnormal posture.

In a preliminary study, we investigated the relationship between TMD symptoms and upper quadrant posture of young women using an ultrasound-based (US-based) three-dimensional (3D) motion analyser to confirm objective outcomes for posture analysis[14)]. Our preliminary study reported that young women with the TMD symptoms of temporomandibular joint (TMJ) pain, masticatory muscle pain, or a limitation in mouth opening presented a significant forward head posture compared to those with no TMD symptoms[14)]. However, the participants investigated in our preliminary study were not TMD patients as diagnosed by a dentist, but were categorised as TMD patients according to their self-report of TMD symptoms. Following the publication of our preliminary study, a subsequent study by Uritani[15)] demonstrated that in the analysis of posture, a US-based 3D motion analyser had moderate-to-high intrarater and interrater reliabilities with little systematic bias. Therefore, the present study investigated the characteristics of upper quadrant posture of young women diagnosed with TMDs using a US-based 3D motion analyser.

SUBJECTS AND METHODS

The participants were 19 female patients with TMDs diagnosed by specialists certificated by the Japanese Society

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for TMJ (patient group), and 14 healthy controls without TMDs, as diagnosed by the specialists (control group). Inclusion criteria were female gender, an age of 20–49 years (to reduce the possible influence of menopause and degenerative changes in the spine), no history of surgery on the upper quadrant, and the absence of mental illness or its possibility. All participants in the patient group were diagnosed with TMDs based on myalgia of the masticatory muscle and/or TMJ disc derangement, while the control group consisted of volunteers. None of the participants had received consultation or treatment for the correction of posture. The descriptive characteristics of both groups are presented in Table 1. The body mass index (BMI) was calculated based on height and weight. The local ethics committee approved the study, and each participant provided their written informed consent to participation in the study prior to the study's initiation.

Posture measurements were performed using a US-based 3D motion analyser (CMS20S, Zebris, Germany). During the posture analysis, the participants were asked to stand in a relaxed position, with their arms hanging by the sides of the body, and facing the front. They were positioned approximately 1 m from the transmitter. Reference points were the eye edge, ear tragus, the spinous process of C7, and the acromial angle. These reference points, with the exception of the spinous process of C7, were bilaterally identified. Identification of the reference points was performed by palpation, and the reference points were marked by a pointer. The procedures were repeated in the order dictated by the system's software routine, with two measurements performed for each reference point. The tester was a physical therapist with 14 years of clinical experience who had primarily treated patients with musculoskeletal disorders.

The postural parameters analysed were: the neck inclination angle, formed by a line connecting C7 and the tragus with a horizontal line[6, 7, 16]; the angle of the shoulder, formed by a line connecting C7 and the acromial angle with a horizontal line[6, 7]; the cranial rotation angle, formed by a line connecting the tragus and the corner of the eye with a horizontal line[16]; and the neck-length/shoulder-width ratio, calculated by the ratio of the neck length (from C7 to the tragus) to the width of the shoulder between the acromial angles (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, with the exception of the neck-length/shoulder-width ratio. The mean value was not calculated for both sides of this parameter because the status of the tissues adjacent to the TMJ and the movement of the TMJ are affected both unilaterally and bilaterally by the posture. The mean values of the two measurements of each parameter were calculated. The maximum range of mouth opening was measured by dentists using a scale.

In our previous study in which the neck inclination angle, the angle of the shoulder, and the cranial rotation angle were evaluated[15], the intrarater and interrater reliabilities ranged from moderate to almost perfect agreement based on the criteria described by Landis and Koch[17].

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

Table 1. Descriptive characteristics of the participants

	Patient group (n = 19)	Control group (n = 14)
Age (years)	30.1 (8.9)*	24.6 (6.1)
Height (cm)	158.1 (4.6)*	161.8 (5.4)
Weight (kg)	48.6 (5.7)	52.4 (5.3)
BMI (kg/m/m)	19.4 (1.7)	20.0 (1.9)

All data are expressed as the mean (SD). *p < 0.05

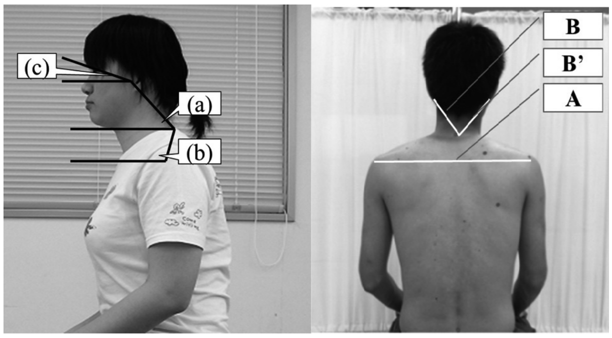

Fig. 1. Postural parameters
(a) neck inclination angle, (b) angle of the shoulder, (c) cranial rotation angle, and (d) neck-length/shoulder-width ratio. The ratio of the neck length (C7 to the tragus) to the width of the shoulder between the acromial angles was calculated using the formula (B+B')/2/A×100%.

RESULTS

The mean age of the patient group (30.1 ± 8.9 years: range, 20–43 years) was significantly greater than that of the control group (24.6 ± 6.1 years: range, 20–41 years; $p < 0.05$). Meanwhile, the mean height of the patient group was significantly lower than that of the control group (158.1 ± 4.6 cm vs. 161.8 ± 5.4 cm, $p < 0.05$). No significant differences in body weight or BMI were observed between the study groups (Table 1).

The neck inclination angle of the patient group (55.2 ± 5.1 degrees) was significantly smaller than that of the control group (62.3 ± 6.3 degrees, $p < 0.01$). Additionally, the maximum range of mouth opening was significantly smaller in the patient group than that of the control group (44.1 ± 6.1 mm vs. 49.7 ± 5.5 mm, $p < 0.05$). Significant differences were not observed in the angle of the shoulder, the cranial rotation angle, or the neck-length/shoulder-width ratio (Table 2).

DISCUSSION

In this study, the smaller neck inclination angle observed in the patient group indicates the head position of the young female patients with TMDs was more anterior than that of those without TMDs. Hence, our results support previous

Table 2. Postural parameters and range of mouth opening

	Patient group	Control group
Neck inclination (degrees)	55.2 (5.1)**	62.3 (6.3)
Angle of shoulder (degrees)	108.2 (9.3)	116.0 (15.2)
Cranial rotation (degrees)	19.7 (5.2)	20.5 (6.4)
Neck length/shoulder width (%)	35.2 (2.8)	36.2 (4.0)
Range of mouth opening (mm)	44.1 (6.1)*	49.7 (5.5)

All data are expressed as the mean (SD). *$p < 0.05$, **$p < 0.01$

work identifying an association between abnormal head posture and TMDs. Moreover, the range of mouth opening of the TMD patients was smaller than that of the controls. Collectively, these findings might have relevance for the treatment of TMD.

In the present study, the neck inclination angle of the patient group was 7.1 degrees smaller than that of the control group. In the study of Braun[6, 14] and our preliminary study, the difference in the neck inclination angle between women with and without TMD symptoms was ~7 degrees. Hence, our findings are in agreement with the results of these previous studies. Uritani[15] demonstrated that the minimum detectable change at the 95% confidence level in the neck inclination angle as measured using the US-based 3D motion analyser was ~8 degrees. Therefore, the significant difference in the neck inclination angle between the patient and control groups in the present study might have clinical importance.

The resting position of the mandible is affected by head posture[18, 19]. In addition, the influence of head posture on the kinematics of the TMJ might be related to stretching and/or elongation of the opening and closing muscles of the TMJ and of other soft tissues attached to the mandible, with the force of gravity exerting varying influence on the mandible[19]. Yamada et al.[20] demonstrated that the increased activity of the temporal muscles that occurs when the head is bent backward results in backward traction on the mandible during the closing movement, as well as a closing path from the posterior direction. Therefore, forward head posture may give rise to abnormal mechanical stresses on the TMJ and adjacent tissues, and influence the arthrokinematics of TMJ. These processes may result in TMJ pain. Furthermore, Goldstein et al.[18] observed increased masticatory electromyographic levels with cervical backward bending, and Boyd et al.[21] found that cervical backward bending increased the activity of the temporalis muscles. Moreover, the 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 TMJ disc. These processes may cause TMJ pain and masticatory muscle pain and a restricted range of mouth opening. Indeed, the maximum range of mouth opening of the patient group was significantly smaller than that of the control group in the present study, which is consistent with the results of our preliminary study[14].

In the present study, no significant differences in the angle of the shoulder were observed between the study groups. An increased angle in the shoulder indicates protraction of the scapula, while a decreased angle indicates retraction of the scapula. In terms of anatomy, the positional relationship between the shoulder girdle and mandible or cranium may have an influence on the TMJ through several muscles, such as the trapezius, sternocleidomastoid, platysma, and hyoid muscles. However, the angle of the shoulder was not related to TMDs. This finding is consistent with the results of our preliminary study[14]. With respect to the cranial rotation angle, there was also no significant difference between the study groups, which is likewise in agreement with our preliminary study[14]. The participants in the present study were asked to face the front and gaze at the level of the line of sight. Therefore, cranial rotation in the sagittal plane did not change regardless of the head position relative to the trunk. In addition, the standard deviation in the cranial rotation angle was large relative to that of the neck inclination angle and the angle of the shoulder. Uritani[15] reported that the cranial rotation measured by the US-based 3D motion analyser presented a high measurement error compared with the neck inclination angle and the angle of the shoulder. This increased measurement error might have influenced the results of our present study. Because the BMI was not significantly different between the groups, the neck-length to shoulder-width ratio did not present significant differences between them.

This study had several limitations. First, the patient group was older than the control group by ~6 years, and had a lower height than the control group. However, both groups were treated as homogeneous in the present study because no significant difference was observed in their BMIs, and the two groups could be considered to be of the same generation. Nonetheless, future studies with larger sample sizes need to adjust for these types of significant differences. Second, the participants were women who ranged in age from 20 to 43 years. Therefore, the results of this study cannot be generalised beyond this population. Several studies have described the prevalence and severity of TMD as decreasing after menopause[2–5]. Degenerative changes in the cervical spine also occur with aging. These factors would influence the upper quadrant posture of elderly patients with TMDs. Therefore, the association between TMDs and the upper quadrant might differ in postpartum women. Future studies should investigate female TMD patients with respect to the influence of menstruation. Further, the physical constitution differs between the female and male genders. Hence, future studies will need to address whether a similar association between TMDs and upper quadrant posture exists in men as well as women. Finally, the patient group was represented by two types of TMDs (i.e. myalgia of the masticatory muscle and TMJ disc derangement). Abnormal posture might have different influences on the masticatory muscles and TMJ disc. Future studies are required to analyse the association between abnormal posture and the subtype of TMDs.

In conclusion, the head posture was more anterior in young female patients with TMDs than in those without TMDs, while the range of mouth opening of the TMD patients was smaller than that of the controls. Thus, TMDs in young females are associated with the head position relative to the trunk. A posture-correcting method might have a beneficial effect on TMDs in young female patients.

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