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The Effect of Different Head Positions in Sitting on Head/Shoulder Posture and Muscle Activity

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Purpose: This study was to investigate whether the two different head postures, natural and ideal head posture, affect head/shoulder posture and muscle activity.

Methods: Thirty healthy subjects with the forward head and round shoulder posture were participated in this study. This study utilized a within-subjects design with subjects being positioned into two sitting positions: natural head posture (NHP) and ideal head posture (IHP). Forward head angle (FHA) and forward shoulder angle (FSA) of each subject were measured for assessing the head/shoulder posture and muscle activities of upper trapezius (UT), lower trapezius (LT), and serratus anterior (SA) during the forward overhead reaching.

Results: There were significant increases in both FHA and FSA after taking IHP, which showed greater angles than in taking NHP. In change of muscle activities, there were significant decreases in both LT and SA after taking IHP, which showed lower activities than in taking a NHP, whereas there was no significant change in UT.

Conclusion: These findings demonstrate that postural alterations associated with forward head and rounded shoulder postures could alter scapular kinetics and muscle activity during the forward overhead reaching.

Keywords: Head position, Muscle activity, Shoulder

I. Introduction

Poor sitting posture is associated with increased forward head, anterior rounded shoulder position, and greater thoracic kyphosis, altered scapular position, kinematics, and muscle activity.[1-5] These alterations increase muscle tension and stress on the neck and shoulder, resulting in pain, numbness, loss of function, and a variety of neuromuscular symptoms, most often in the upper body.[6-9] Forward head and rounded shoulder posture and altered scapular kinematics and muscle activity have been reported in patients with subacromial impingement syndrome, rotator cuff disorder.[10-12]

In sitting posture, forward head involves a combination

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of lower cervical flexion, upper cervical extension, and rounded shoulders, and reduces the average length of the muscle fibers, which contributes to extensor torque aroundbout the upper cervical joint.[13-15] It is possible that this shortening reduces the tension-generating capabilities of the muscles. In addition, a flexed spine results in higher activity in the upper trapezius, cervical and thoracic erector spine muscles.[16] Development of neck-shoulder symptoms in forward head posture may be associated with prolonged trunk flexed posture with increased muscle activity of the neck-shoulder stabilizers resulting in higher levels of cervical spine loading. In support of this, previous study reported that individuals with chronic neck pain demonstrate a reduced ability to maintain an upright neutral sitting posture.[16-18]

Forward head posture and trunk flexion has been linked to musculoskeletal dysfunction of the neck and trunk such as upper crossed syndrome.[11,19,20] The upper crossed syndrome is associated with tightness of the upper trapezius, pectoralis major, levator scapulae, and suboccipitalis muscles, and weakness of the rhomboids, serratus anterior, middle and lower trapezius and deep neck flexor muscles. These weakness and tightness of muscles are connected in the upper body, resulting in elevation and protraction of the shoulders, kyphosis, forward head posture, and loss of cervical lordosis. In particular, individuals with forward head posture and trunk flexion display less scapular upward rotation as well as greater internal rotation and anterior tilting that is caused by imbalance of neck-shoulder result from unilateral myofascial forces acting on the musculoskeletal system.[21-23]

Many previous studies have reported that proper head posture is considered to be a state of musculoskeletal balance that involves minimizing the stresses and strains acting on the upper body.[16,17,22] It has been proposed that frequent correction to an upright neutral postural position serves two functions: first, that may provide a regular reduction of adverse loads on the cervical joints induced by poor spinal, cervical and scapular postures. Second, it may train the deep postural stabilizing muscles of the spine in their functional postural supporting role. Hence, assuming the proper head posture is a common treatment approach for and shoulder pain syndromes. However, although forward head posture as a contributor to the development of chronic neck, shoulder pain, headache, and even jaw pain is well established, it is important to understand the effects of assuming proper head posture on scapular kinetics and muscle activity because forward head and rounded shoulder can be modifiable. In addition, it may provide a pathway to improve upper body mechanics and decrease the risk to develop musculoskeletal pain of neck and shoulder. Therefore, in the current study, we investigate whether the two different head postures, natural and ideal head posture, affect head/shoulder posture and muscle activity.

II. Methods

1. Subjects

Thirty healthy subjects with the forward head and round shoulder posture were participated in this study (Table 1). Forward head and rounded shoulder posture were defined as forward head angle (FHA) $\leq 54.0°$ and forward shoulder angle (FSA) $\leq 50.0°$ based upon the respective angles between the center of the markers.[15,24] Inclusive criteria were as following: (1) free of neck and shoulder pain, (2) no pathology of musculoskeletal function in the upper limb, (3) no previous history of neurological or psychiatric disorders. All subjects understood the purpose of this experiment and gave their written informed consent prior to participation.

2. Experimental methods

1) Postural measurement

Table 1. Descriptive statistics for all subjects with forward head and rounded shoulder posture.

Characteristics	Mean ± SD
Male	13
Female	17
Age (years)	21.40 ± 1.75
Height (cm)	166.07 ± 9.04
Mass (kg)	59.53 ± 11.18
FHA (°)	52.18 ± 4.60
FSA (°)	48.60 ± 3.69

FHA=Forward head angle; FSA=Forward shoulder angle

Forward head and round shoulder posture of each subject was assessed using the digital camera (EOS 1000D, Cannon, Japan) to capture the sagittal plane of the upper body in sitting position. Reflective markers were placed over the right tragus of ear, acromion, and C7 spinous process.[22] Adobe Photoshop (San Jose, CA, USA) was used to determine FHA and FSA from the lateral photograph. FHA was measured from the vertical anteriorly to a line connecting the tragus and the C7 marker. FSA was measured from the vertical posteriorly to a line connecting the C7 marker and the acromial marker. Digital camera was placed on a tripod 1 m high and 3.5 m from the wall. Next, the subjects sit 40 cm in 40 cm front of background wall, bent forward 3 times, reached overhead 3 times, and were instructed to sit looking straight ahead in their comfortable and natural resting posture. This procedure has been used in previous published studies.[15,22,25] Reliability and validity of FHA and FSA wereas well established.[26,27]

2) Electromyography (EMG) data collection

EMG data were collected using a four channel surface EMG system (MP30, Biopack, USA). Recording of EMG signals was accomplished using preamplified electrode (Biopac System, Biopack, USA). Surface EMG signals from the following three muscles were measured while the subjects reached overhead at sitting position: upper trapezius, lower trapezius, and serratus anterior muscles which are superficial and gross muscles and are related with poor sitting position. The activities of these muscles on the subject's right side were detected by surface electrodes that were attached to skin having been sanded and then cleaned using rubbing alcohol. EMG electrode locations were as follows: (1) upper trapezius (UT) was lateral to the half-way point of an imaginary line formed by the posterior aspect of the acromion and the spinous process of C7,[28] (2) lower trapezius (LT) was next to the medial edge of the scapula at an obligue angle of 55°,[29] (3) serratus anterior (SA) was just below the axillary area, at the level of the inferior tip of the scapular, and just medial to the latissimus dorsi.[30] A ground electrode was placed on the right clavicle. All EMG data were converted to digital signal that were recorded by using Acqknowlege software (Biopac System, Biopack, USA) for data processing. Data was sampled at 1000 Hz and bandpass was filtered between 10 and 500 Hz.

3) Procedures

This study utilized a within-subjects design with subjects being positioned into two sitting positions: natural head posture (NHP) and ideal head posture (IHP). In a natural head posture, subjects were instructed to sit in a comfortable position so that subjects feels natural with a verbal instruction like as 'sit as you usually do', while looking conveniently forward (Figure 1).[16]

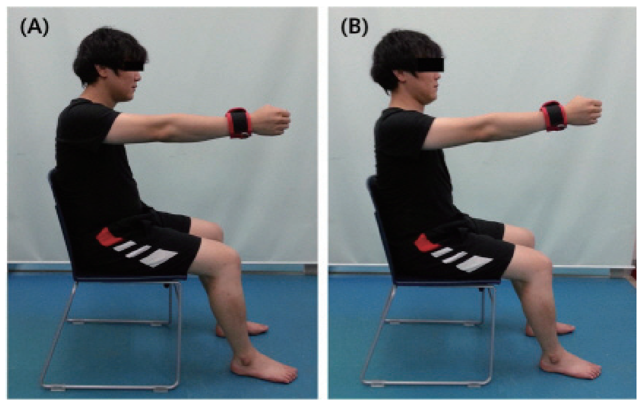

Figure 1. Natural head posture (A) and ideal head posture (B) during the forward overhead reaching.

In an ideal head posture, subjects were instructed to sit in an imagined position which make a feel of ideal for oneself with 'sit as you think is the ideal posture' (Figure 1).[16]

Generally, when compared to IHP, NHP was found to be associated with increased thoracic flexion and head/neck flexion with a greater anterior translation of the head. They were not given any other instructions, and did not receive any feedback on their postures. These postures were held for 10 seconds and repeated 3 times, with a 10 seconds relaxation period in between each repetition. FHA and FSA of each subject were measured 3 times, for 3 separate days and the average angles both in NHP and IHP were used for subsequent analysis. In order to measure muscle activity, each subject reaches their right arm forward overhead for 3 repetitions 3 sessions. Forward overhead reaching required the subject to lift a weight equal to 3 % of their body weight withtheir elbow straight

Table 2. The change of head/shoulder posture and muscle activity values (%MVIC) during the forward overhead reaching.

	NHP (Mean ± SD)	IHP (Mean ± SD)	p
FHA	51.72 ± 3.96	53.84 ± 3.69	0.02*
FSA	47.67 ± 2.10	52.55 ± 4.38	0.00*
SA	64.88 ± 27.88	53.94 ± 23.82	0.01*
LT	28.40 ± 13.17	18.57 ± 10.56	0.04*
UT	31.39 ± 18.45	24.36 ± 12.39	0.09

*p<0.05; %MVIC=%Maximal voluntary isometric contraction; NHP=Natural head posture; IHP=Ideal head posture; FHA=Forward head angle; FSA=Forward shoulder angle; SA=Serratus anterior; LT=Lower trapezius; UT=Upper trapezius

and non-elevated shoulder. Subjects were instructed to lift right arms from a position of arms relaxed at their side up to 180 degree at a self-selected speed. Subjects rested 30 seconds between repetitions to prevent fatigue. The root mean square (RMS) values of the EMG data were calculated then maximal EMG signals for normalization were acquired during maximum voluntary isometric contractions (MVIC) for 5 seconds. The values of the first and last one second discarded and the mean RMS of middle 3 seconds was calculated. The EMG data were calculated over a 20 ms time constant during the ascending phase of humeral elevation for the UT, LT, and SA muscles. The %MVIC was measured three times and there was a 60 seconds rest period between each of the three trials. The mean %MVIC over the ascending phase of motion was averaged for repetitions three trials and used for statistical analyses.

3. Statistical analysis

All data and two dependent variables, such as postural angles (FHA and FSA) and muscle activities (UT, LT, and SA), were analyzed using PASW 18.0 for Windows. The paired t-test was used to compare the dependent variables between NHP and IHP. All measurements were shown as average ± standard deviation and were verified at a significant level $p<0.05$.

III. Results

Table 1 shows demographic data of the subjects. All subjects tended to be similar in age, weight, and height.

In change of postural angles, there were significant increases in both FHA and FSA after taking an IHP, which showed greater angles than in taking a NHP; FHA and FSA were 51.72 and 47.67, respectively, and they were 53.84 and 52.55 in taking a IHP ($p<0.05$)(Table 2). In change of muscle activities, there were significant decreases in both LT and SA after taking an IHP, which showed lower activities than in taking a NHP; LT and SA were 28.40 and 64.87, respectively, and they were 18.57 and 53.95 in taking an IHP ($p<0.05$)(Table 2). The UT was decreased after taking an IHP but there was no significant change; UT was 31.39 in taking a NHP, and it was 24.36 in taking an IHP ($p>0.05$)(Table 2).

IV. Discussion

In the current study, we investigated whether different sitting positions natural and ideal head postures, have an effect on head/shoulder posture and muscle activity during the forward overhead reaching. Postural angles, the FHA and FSA, were measured for kinetics of upper trunk, and muscle activities such as UT, LT, and SA were assessed for movement pattern of scapular during the loaded shoulder flexion between NHP and IHP. As a result, comparing the position of the NHP with the IHP, the FHA and FSA were significantly increased, and muscle activities of LT and SA were significantly decreased in the self-applied head posture, but UT muscle was not. These results imply that shoulder kinetics and movement patterns change for the better in assuming an IHP. In addition, this provides evidence that subjectively perceived ideal posture of head and shoulder contributes to altered shoulder kinetics and muscle activity in individuals free from shoulder pain with forward head and rounded shoulder during a functional forward overhead reaching.

Our findings showing a decline in both FHA and FSA, were in line with previous studies, which subjects with forward head and rounded shoulder postures displayed greater scapular anterior tilting angles when compared to individuals with ideal posture.[3,4,31] Previous study has reported that natural and habitual head posture was associated with increased thoracic flexion and head-neck flexion with a greater anterior translation of the head, when compared to neutral head-neck alignment with shoulder blades slightly retracted.[16] In addition, the difference of 3~4° is similar to changes in scapular anterior tilting which attributed to greater thoracic kyphosis, shorter pectoralis minor length.[3,4] In the current study, IHP demonstrated FHA and FSA that were respectively on average 2° and 4° lower than FHP during forward overhead reaching. The observed differences in FHA and FSA are likely the result of muscular imbalances around the shoulder girdle since this study measured muscle activities of UT, LT, and SA.

Serratus anterior activity was lower during the forward overhead reaching and may help explain the alterations in scapular upward rotation and posterior tilting. Serratus anterior contributes to produce and control for anterior/posterior tilting and upward/downward rotation of the scapular.[5,12,21] Therefore, we believe that lower activity of serratus anterior may be playing a key role in alterations of scapular kinetics. Moreover, our results showed less amounts of lower trapezius activity between NHP and IHP, suggesting the alteration in kinetics was likely the result of lower serratus anterior activity. Many previous studies have reported that alterations in upper and lower trapezius timing and activity play an important role in controlling and producing scapular anterior/posterior tilting and upward/downward rotation during the forward overhead reaching.[6,12,22] The assumed role of the serratus anterior and the lower trapezius are as an upward rotator. However, the absence of differences was observed in upper trapezius activity. It is possible that there are other motions contributing to scapular upward rotation in the upper ranges of humeral elevation that we did not measure such as clavicular elevation. Several previous studies have shown clavicular elevation to occur concurrent with scapula upward rotation.[5,32,33] This movement pattern may explain the increases in scapular upward rotation. These results support rehabilitative focus on the serratus anterior and the lower trapezius in subjects with FHP, especially in the higher ranges of humeral elevation. Therefore, considering scapular alterations, it appears that forward head and rounded shoulder postures has a more global effect on scapular kinetics, while pectoralis minor tightness primarily affects scapular tilting and rotation although we did not make this direct comparison.

There were some limitations of this study which need to be acknowledged. First, we did not differentiate between the upper and lower cervical spine kinetics and the deep and superficial cervical and sub-occipital muscles were not measured in this study. Second, the personal postural habits of the subjects were not been assessed in this study as the aim was to assess the influence of two pre-defined head postures on head/shoulder angle and muscle activity. In conclusion, this study showed that all defined sitting positions with natural and ideal head postures resulted in various changes in head-neck and neck-shoulder angles and muscle activation. In addition, ideal head/shoulder posture results in altered scapular as well as muscle activity of the shoulder girdle. Therefore, this study supports for the clinical theory that postural alterations associated with forward head and rounded shoulder postures can alter scapular kinetics and muscle activity during the forward overhead reaching. Moreover, taking ideal head/shoulder posture may contribute to the therapeutic strategy for the individual with forward head and round shoulder. Future studies should determine scapular kinetics and muscle activity in patients with shoulder pain forward head and rounded shoulder postures, and the effects of interventions to improve posture for shoulder pain and disability.

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