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Research Article

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The Analysis of severity of forward head posture with observation and photographic method

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| Abstract |

PURPOSE: This paper aims to present the available angle to evaluate the severity of forward head posture (FHP) with the observation method and photographic method.

METHODS: A cross-sectional observation research design study consisted of 29 subjects who was divided two groups (slight FHP group, moderate FHP group) in Eulji university was used. We evaluated the FHP and the angles including CranioVertebral Angle (CVA), Head Tilting Angle (HTA), Head Position Angle (HPA) and Forward Shoulder Angle (FSA) with the Body style S-8.0 (South Korea, LU Commerce).

RESULTS: The mean of CVA, FSA from the slight FHP group was shown higher than moderate severe FHP group. According to independent t-test result, but there was no difference among all angles in two groups. The linear discriminate analysis showed the size of distinction of FSA was the biggest, and then CVA, HTA and HPA were in the order. 55.6% of FSA is properly classified in the slight FHP group.

CONCLUSION: The FSA is the best to distinguish the severity of FHP and then CVA as the second best. Therefore, FSA is recommended to check the FHP.

Key Words: Posture, Evaluate, Angle

Ⅰ. Introduction

The forward head posture (FHP) is that the head shown on the sagittal plane is not stable, which appeared by the external auditory meatus that passes through the shoulder joint before the plumb line. Until today, the numbers of the patients who have FHP has been increasing due to the multiplied usage of the electric devices like cellphones and computers. The FHP is absolutely harmful for human's body. So it has to be taken good care of foremost because it deals a lot with not only cervical problems, but also the causation of the temporomandibular joint dysfunction, thoracic kyphosis, and decrease in vital capacity (Pamela and Norkin, 2011).

There are quite many methods to evaluate such atypical posture problems, but the observational method along with

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visual assessment to analyze the posture by using anatomical landmark suggested by Kendal is most frequently used in the clinic (Salahzadeh et al, 2014) because of the technical and cost problem (Gadotti and Magee, 2008). However, Gadotti and Biasotto-Gonzalez (2010) mentioned that there was a disadvantage to find out the difference between the slight FHP and Healthy Neck Posture (HNP) while it was pretty easy to figure out the difference between FHP and HNP by using the observational method.

The second easiest and simplest way of analyzing the FHP in clinic is the photographic method (Gadotti and Biasotto-Gonzalez, 2010). It was reported that this method has high reliability (Gadotti and Magee, 2008; Refshauge et al, 1994; do Rosario, 2014) and validity (Grimmer-Somers et al, 2008). However, the accuracy might markedly differ in the way that it really depends on where the adhesive markers are attatched to the patient's body (Rosário et al, 2012). The used angles to analyze the FHP while using photographic method is Craniovertebral angle (CVA), Head position angle (HPA), and Head tilt angle (HTA). CVA is used most frequently (Brink et al, 2009; Gadotti and Biasotto-Gonzalez, 2010; Salahzadeh et al, 2014; Gadotti and Magee, 2008; Cuccia and Carola, 2009; Cheung Lau et al, 2009; Silva et al, 2010).

Salahzadeh et al, (2014) believed measuring CVA is a better way than checking the both HPA and HTA to distinguish between the normal head neck posture and the severe FHP. It means that CVA could be used as a great indicator on FHP (Gadotti and Biasotto-Gonzalez, 2010; Gadotti and Magee, 2008). However the good indicator to assess FHP except CVA has not researched yet.

According to, Szeto et al (2002), in the case of the office worker who has been dealing a lot with FHP and cervical discomfort, his acromion is protracted. Moreover, as Thigpen et al (2010) said, the most ideal Forward Shoulder Angle (FSA) is 14.9 degrees. When the person with FHP has the protracted shoulder problem, the angle goes up to 57.5 degrees. Because this type of deformation can affect the scapular position and kinematic, it can even cause shoulder impingement. That is why it really is imperative to check on not only the cervical angle, but the posture of shoulders too.

Because both observation and photographic methods are pragmatic in a clinic, it is absolutely more preferable to use both ways than just one. So providing any false idea would not happen when analyzing the posture. Besides it is crucial to use both methods not to drop a clanger when the best way should be found and is used to estimate the severity of FHP.

Therefore, this paper aims to present the available angle to evaluate the severity of FHP with the observation method and photographic method

Ⅱ. Method

1. Subject

This is a cross-sectional observational research design study consisted of 29 subjects in Eulji university. This study was approved by the ethical committee from Eulji University and this study adhered to the ethical principles of the Declaration of Helsinki.

The subjects were informed about the experiment before their agreement to participate. Inclusion criteria were: FHP above 2.5 cm; NDI above 3 score; no history of concussion or mild neck injury in 12 months; no severe thoracic kyphosis and persistent respiratory problems (Cuccia and Carola, 2009; Salahzadeh et al, 2014).

2. Measurement

1) Photogrammetry

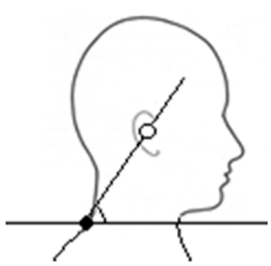
We measured the posture with the Body style S-8.0(South Korea, LU Commerce) and used the Body Style analyzer (system software) to evaluate the FHP. The

subjects were instructed to stand in their natural standing position on postural pad and took pictures of lateral view of the subjects. The intrarater and interrater evaluations of photogrammetry findings in the standing sagittal posture of the cervical spine were found to be reliable (Ruivo et al, 2015; do Rosario, 2014). Data of photography was transferred to the Body Style analyzer and analyzed. We used body markers using double side tape over each landmark, including the tragus of the ear, the spinous process of the C7 vertebra, the external corner of the eye, the tragus of the ear, the sternal notch of the manubrium, the center point of shin and acromion. The plumb line defined the true vertical line on digital images in order to detecting FHP. Normal posture is that the external ear meatus must be in vertical alignment with the middle of the shoulder by Kendall's definition (Gadotti and Biasotto-Gonzalez, 2010)

2) Forward head posture measurement

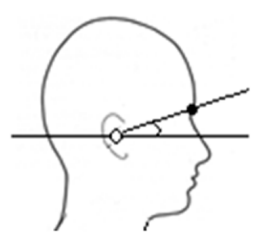
Posture in photographs was assessed by one evaluator. FHP was determined on digital images based on observation and reviewing the status of the participant's head and neck compared to the plumb line. The distance from the line through acromion to the line through the external auditory meatus was measured for the FHP. FHP was calculated using the Body Style Analyzer with markings at the ear tragus and the acromion. If the distance was above 2.5-5 cm, it was defined FHP.

After FHP was assessed, subjects were divided to 2 groups: slight FHP group and moderate- severe FHP group. If the distance was 2.5-5 cm, it was defined as slight FHP and if the distance was >5cm, it was defined as



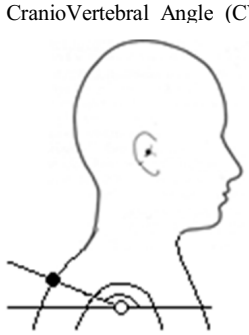
○ Spinal process of C7
● Tragus of ear

A : CranioVertebral Angle (CVA)



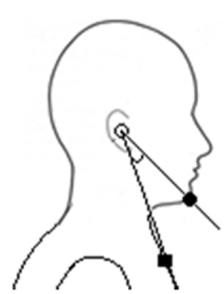
○ Tragus of ear
● Canthus of eye

B : Head Tilt Angle (HTA)



○ Spinal process of C7
● The midpoint of humerus

C : Forward Shoulder Angel (FSA)



○ Tragus of ear
● Mentum of chin
■ Manubrium

D : Head Position Angle (HPA)

Fig. 1. Photogrammetric method for measuring the four postural angles.

Table 1. The general characteristics of the subjects(Mean ± SD)

Group	Age(years)	Height(cm)	Weight(kg)
Group 1(n=9)	23.88±2.11	173.77±6.90	70.22±9.27
Group 2(N=20)	23.20±3.50	173.37±7.52	67.85±11.94

SD: Standard Deviation

Table 2. Descriptive characteristics of CVA, HTA, HPA, FSA and demographic statistics in two groups and results of independent t-test

	Slight FHP group (Mean ± SD)	Moderate-severe FHP group (Mean ± SD)	Independent t- test	
			P	F
CVA(degree)	59.02 ± 3.09	57.51 ± 4.82	0.26	1.27
HTA(degree)	14.29 ± 3.04	14.37 ± 6.29	0.09	2.99
FSA(degree)	155.90 ± 9.74	143.05 ± 12.49	0.86	0.02
HPA(degree)	29.54 ± 4.06	29.34 ± 3.90	0.81	0.05

※ CVA : Craniovertebral Angle , HTA : Head Tilt Angle, HPA : Head Position Angle, FSA : Forward Shoulder Angle, FHP : Forward Head Posture
SD: Standard Deviation

Table 3. Homogeneity Test of Mean value of varables

	Wilk's Lamda	F	P
CVA	0.97	0.74	0.39
HTA	1.00	0.00	0.97
FSA	0.78	7.41	0.01*
HPA	0.99	0.01	0.90

* P<0.05
※ CVA : Craniovertebral Angle, HTA : Head Tilt Angle, HPA : Head Position Angle, FSA : Forward Shoulder Angle

moderate-severe FHP (Kim, 2012).

3) Angle analysis

Posture in photographs was assessed by one evaluator and reliability analysis of the angles measured on the photographs was performed previously. The ICC was 0.99 with a standard error of measurement of 0.45 (Ruivo et al, 2015).

The craniovertebral angle (CVA) refers to the degree of FHP and is defined as the angle between the true horizontal through the spinous process of C7, with a line connecting spinous process of C7 with the tragus on photographs (Brink et al, 2009; Gadotti and Biasotto-Gonzalez, 2010; Salahzadeh et al, 2014; Gadotti and Magee, 2008; Cuccia and Carola, 2009; Cheung Lau et al, 2009; Silva et al, 2010). In general, subjects with smaller the CVA indicates more FHP (Gadotti and Biasotto-Gonzalez, 2010; Salahzadeh et al, 2014; Gadotti and Magee, 2008) (Fig. 1-A).

The head tilt angle (HTA: gaze angle) is the angle which is used to evaluate the head tilt and represents the upper cervical flexion or extension position(Brink et al, 2009; Salahzadeh et al, 2014). The angle is defined the angle between the line connecting the tragus of the ear to the canthus of the eye and the horizontal line passing through the tragus (Salahzadeh et al, 2014; Raine and Twomey,

Table 4. The canonical discriminate functions for Forward Shoulder Angle (FAS)

Predictable variable	Wilk's Lamda**	Chi-sguare	df	Canonical correlation	sig	Box's M sig
FSA	0.78	6.42	1.00	0.46***	0.01*	0.43****

* The result indicates the significant wilk's Lamda for FSA variable
** Wilk's Lamda indicate the significant of canonical discriminate function
*** Canonical correlation 0.46 shows the FSA explains the 21.52% of variation of two groups (the larger canonical correlation, the more discriminate accuracy)
**** The result indicates the significant Box's M for FSA variable

Table 5. Structure matrix

	Discriminant function
Forward Shoulder Angle (FSA)	1.00
Head Position Angle (HPA)	-0.19
Head Tilt Angle (HTA)	-0.05
Craniovertebral Angle (CVA)	-0.02

Table 6. Cross - Validation result of Linear discriminate analysis for Forward Shoulder Angle (FSA)

Group	Predicted Group Membership (%)	
	Slight FHP group	Moderate - Severe FHP group
Slight FHP group	55.55	44.44
Moderate -Severe FHP group	25.00	75.00

※ FHP : Forward Head Posture

1997; Thigpen et al, 2010) (Fig. 1-B). The greater HTA indicates the extension of the head relative to the cervical spine (Salahzadeh et al, 2014; Raine and Twomey, 1997).

Shoulder angle(FSA: Forward Shoulder Angle) is the angle formed at the intersection of the line between the midpoint of the humerus and spinous process of C7 and the horizontal line through the midpoint of the humerus (Brink et al, 2009; Raine and Twomey, 1997)(Fig. 1-C). The smaller angle indicates a relatively forward shoulder in relation to C7 (Raine and Twomey, 1997).

The head position angle (HPA) evaluates the head status in relation to trunk and indicates the vertical distance between the chin and sternum. This angle is defined as angle between the tragus manubrium line and the line extending from the center point of chin to the tragus (Fig. 1-D). The larger head position angle indicates more FHP (Salahzadeh et al, 2014).

4) Data Analysis

We computed the average of postural angle and degree of FHP (divide two groups) and used Kolmogorov-smimov test to asses if the variables were randomly distributed. The descriptive analysis was used to assess the characteristics of subjects. The independent t-test was used to compare two groups. Linear discriminate analysis was used to determine the most important photogrammetric methods (CVA, HTA, HPA and FSA) to distinguish the degree of FHP (two groups). Statistical analysis was performed using SPSS 18.0 and significance was accepted for values of $p<0.05$.

Ⅲ. Results

1. The general characteristics of the subjects

The general characteristics of the subjects are shown in Table 1. The general characteristics of the subjects except age showed no significant difference between groups, indicating that they were homogenous groups. The Kolmogorov-Smirnov test indicated that the dependent variables of CVA, HTA, FSA and HPA were normally distributed in both groups.

2. Observational and photogrammetric measurements

According to subjective observation, 20 subjects with moderate-severe FHP, 9 subjects with slight FHP were diagnosed. Table2 displays the mean and standard deviation of CVA, HPA, HTA and FSA, and the results of independent t-test. The mean of CVA, FSA from the slight FHP group was shown higher than moderate-severe FHP group. The average of HT and HPA was about the same. The results of independent t-test showed no difference among all angles in two groups. According to the result of Homogeneity test about mean value of variables, CVA, HTA and HPA were not significant. The result of Wilks Lamda of, FSA was 7.412 and the probability of significant was $p<0.05$. It means that statistically there was significant difference between two groups (Table 4) and FSA was an appropriate variable to differentiate the groups (Table 3). According to the result of M's test, covariance relation shows no difference between groups ($p>0.05$) (Table 4).

In the value of structure matrix, the size of distinction of FSA was the biggest, and then CVA, HTA and HPA were in the order (Table 5).

In the cross validation result of liner discrimination analysis for FSA, 55.6% is properly classified in the slight FHP group. 75% is properly classified in the moderate-severe group. Overall, 69% is rightly categorized in each group.

Ⅳ. Discussion

If our posture is wrongly conducted habitually and kept repeatedly and daily, our brains would not be cognitively able to tell us that it is wrong. It also deformalizes ligaments and muscles resulting abnormal posture (Pamela and Norkin, 2011).

Evaluating such abnormal posture is multifarious. The study on this issue has been performed, but each of them has its broken piece that has to be supplemented. It would accurately and mutually be more determinable if observational method and photometric method, as we all know they are most ubiquitous in this field, were applied together. That is the reason why we use exercised both observational and photometric methods to measure the degree of FHP.

Some other researchers insisted FHP is a resting position unlike the concept of FHP that was defined by Kendall et al (2005). They also mentioned that the trunk is bent forward to put the head and eyes on the same line.

The reason why trunk is bent forward is that thoracic is biomechanically related to the neck (Lau et al, 2010). Therefore, not only should thoracic kyphosis be treated (González-Iglesias et al, 2009; Quek et al, 2013), but the degree of kyphosis should be measured too (Refshauge et al, 1994). Thus both FSA and the cervical angle of the subjects who have the FHP were measured well in this study.

In this paper, FSA has decreased in the moderate-severe FHP group. We can interpret that the more severe FSP incurs, the more protracted shoulders and the worse kyphosis were shown.

Quek et al (2013) has reported that kyphosis increase causes the FHP increase and Szeto et al (2002) which has showed that the worker who has the pain in the shoulders and neck has the problem with acromion displaced a bit forward more than C7, compared to the worker who has no pain in the neck and shoulders. Our result is analogous

to other results of researchers (Quek et al, 2013; Szeto et al, 2002). Therefore, we can say that shoulder position is intimately linked with neck position.

Ruivo et al (2014), however, said that the subject who has the neck pain showed the higher angle of shoulder, which is taking totally opposite position of what this study has shown. That is because its method of angle calculation differs from the other. Ruivo et al (2014)'s angle measurement was in the opposite direction, thus if it were used in the same way, Ruivo's result would have shown the decrease of shoulder angle too.

Raine and Twomey (1997), In contrast to former studies, insisted that the FHP is never related to the increase of thoracic curve. Their result is exactly antithetical to this study. The age factor is probably speculated. The method of research is very much like that of this study, but the ages of subjects were promiscuous: the ages varied from 18 to 83 unlike this study using the subjects 20s'. Viewed in this light, variable of age should be considered

The result of Linear Discriminate Analysis on this study, the FSA is an observational approach which is most useful variable to separate the slight FHP group and moderate-severe FHP group. As the CVA, HTA, HPA were put in the size order. They weren't statistically qualified enough to be used as helpful variables.

Following the study of Lau et al (2010), it is reported that the upper thoracic angle was a good predictor for presence of neck pain even better than that of the CVA. The CVA is measured in the most cases when the FHP and the normal group is supposed to be compared(Brink et al, 2009; Gadotti and Biasotto-Gonzalez, 2010; Salahzadeh et al, 2014; Gadotti and Magee, 2008; Cuccia and Carola, 2009; Cheung Lau et al, 2009; Silva et al, 2010). When check on the FHP, measuring the CVA is very meaningful because the CVA's discrimination is the second biggest variable that could distinguish the FHP group slight and moderate-severe FHP group.

In opposition to Lau's study, Salahzadeh et al (2014) claimed measuring the CVA can't evaluate the slight FHP group and severe FHP group by measuring HPA and HTA. Even in this study, the FSA is the only effective variable that the slight group and severe group can be estimated.

It explains that when the severe FHP appears, the FSA increases more, due to the increase of thoracic kyphosis (Quek et al,2013; Szeto et al, 2002; Ruivo et al, 2014). So the FSA has to be measured when checking on the severity of FHP.

Ruivo et al (2014) mentioned the CVA decreases when pain incurs in the neck. Also, Yip et al (2008) and Gadotti and Biasotto-Gonzalez (2010) announced that CVA in subjects with neck pain is significantly smaller than that of normal subjects and the patients with smaller CVA have greater FHP.

The moderate-severe FHP group's CVA was a bit highter than the slight FHP group in this study as well. It is conceived that the more severe FHP posture occurs, the head goes up bit by bit and the center line of gravity gets brought up forward (Hanten et al, 1991).

The limitation of this study was that we did not consider other variables including gender and lumbar spine curvature, pelvic tilt, the alignment of lower limbs, and psychological situation. We should research considering those variables in the future

Ⅴ. Conclusion

In this study, we have tried to get through which pliability can be most effective to discover the severity of FSP on the observational method and studied of CVA, HTA, FSA and HPA with the photographic method. The conclusion to be drawn here is that the FSA is the best one to distinguish between the slight FHP and moderate-severe FHP, and then CVA as the second best. Therefore, FSA is recommended to check the FHP first when searching for the severity of FHP.

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