J. Phys. Ther. Sci.
24: 925–927, 2012

The Effect of Forward Head on Ankle Joint Range of Motion and Static Balance

Hyong In Hyouk, PT, PhD[1)], Kim Jae Hyun, PT, PhD[1)]

[1)] *Department of Physical Therapy, Shinsung University: Daehack-ro 1, Jungmi-myun, Dangjin-city, Chungnam, Republic of Korea.*
TEL: +82-41-3501-356, FAX: +82-41-3501-355, E-mail: anatomy2@shinsung.ac.kr

Abstract. [Purpose] The purpose of this study was to examine the effect of forward head posture on ankle joint range of motion and static balance. [Subjects] The study subjects were on 51 healthy undergraduates (22 males and 29 females) who had not experienced cervical or shoulder pains, or hospital diagnosis of musculoskeletal dysfunction in the previous four weeks. [Methods] The cranial vertical angle (CVA) was measured to investigate forward head posture, and the Tetrax Portable Multiple System (Tetrax Ltd, 56 Miryam Ramat Gan, Sunlight, Israil) was used to measure static balance using the stability test index (STI). Distal dualer-IQ (JTECH Medical, USA) was used to measure ankle joint range of motion. [Results] Cranial vertical angle had an influence on ankle joint plantarflexion, but no influence on static balance. [Conclusion] Forward head posture was shown to transmit tension to the ankle joint through the superficial back-line, one of the myofascial meridians connected to the fascia, which suggests that tension in the neck muscles influence the ankle joints.
Key words: Forward head, Cranial vertical angle (CVA), Myofascial meridian

(This article was submitted Apr. 3, 2012, and was accepted May 17, 2012)

INTRODUCTION

Forward head posture refers to the posture in which the head is placed excessively forward over the top of trunk in the sagittal plane. It creates extension of the upper cervicals, atlas (C1) and axis (C2), and flexion occurs of the lower cervicals (C3–C7). Forward head posture has been reported to be relevant to tensional head ache[1, 2)], neck pain[3)], and cervical pain[4)]. Forward head posture induces muscle contraction and fatigue in the neck and shoulders[5)], and people with forward head posture show reduced range of motion in the neck compared to people with normal anatomical arrangement in the sagittal plane[6)].

Balance is the process of maintaining stability in any posture. Stability of posture is maintained based on complicated processes called recognition and sensory informatization[7)]. Balance control is the ability to control the human body by keeping the center of gravity within of the base of support[8)]. If the head moves forward outside of the base of support, compensational biomechanics take place at the trunk, pelvis, knee, and ankle joints in order to maintain the balance. The ankle joints play an important role in balance control of the lower limbs[9)]. The ankle joints support the body during weight-bearing through cooperative action with the lower limb muscles, and provide sensory information on posture maintenance[10)] responding to small sway of the human body[11)].

Forward head posture results in eccentric contraction of the posterior cervical muscles which influnces balance control by delivering tension to plantarflexion of the ankle through integration with the effect of the fascia[12)]. Myers[12)] summarized fascias connecting human body muscles into 11 major myofascial meridians. The superficial back line is one of these meridians. It connects the gastrocnemius to the hamstrings attached to the ischial tuberosity, the sacrotuberous ligament, thoracolumbar fascia, erector spinae, iliocostalis, epicranial, galea aponeurotica, and frontalis muscles to transmit tension from the head or gastrocnemius to other connected parts. Therefore, forward head posture can influence balance through continuous eccentric contraction of extension muscles in the neck, which is transmitted to the gastrocnemius through the myofascial meridian.

Most studies of forward head posture have examined tension headaches and cervical range of motion. There is a lack of studies on the transmission of tension in the extension muscles of the neck due to forward head posture, and comparative studies of static balance of subjects with forward head posture. Accordingly, the purpose of this study was to measure cranial vertical angle (CVA), as the criterion for determining forward head posture, to measure the changes in static balance and ankle joint range of motion with varying degrees of forward head posture, and to provide evidence of the connectivity of ankle joint range of motion with static balance through the mutual transmission of tension along the muscles of the superficial back line.

SUBJECTS AND METHODS

The study subjects were conducted on 51 students (22 males and 29 females) attending S University located

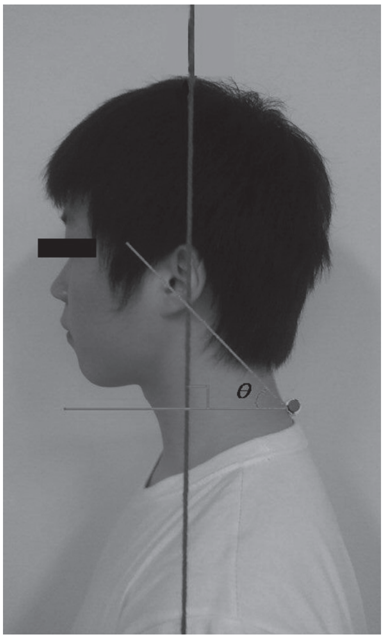

Fig. 1. Measure of cranial vertical angle (CVA, θ) 81 × 135 mm (150 × 150 DPI)

Table 1. Regression analysis of STI, dorsi flexion and plantar flexion by CVA

	M ± SD
CVA (degree)	52.0 ± 5.1
Age (yrs)	21.8 ± 2.1
Height (cm)	166.8 ± 9.7
Weight (kg)	62.0 ± 12.0
STI (pts)	13.6 ± 4.0
dorsi flexion (degree)	70.1 ± 9.6
plantar flexion (degree)	17.9 ± 4.4

CVA: cranial vertical angle, STI: stability test index

in Chungnam Province. The subjects understood details of this study and agreed to participate. The subjects were selected from among healthy undergraduates who had not experienced cervical or shoulder pain, or hospital diagnosis of musculoskeletal dysfunction in the previous four weeks. Subject's head were photographed from the side to measure forward head posture in the sitting position[13, 14]. The camera was uniformly adjusted to shoulder height. A solid line was drawn from the ceiling to the 2/3 point of the ear for balance of human body. The photograph was marked at the 7th cervical spinous process, and a horizontal line passing through the 7th cervical spinous process was drawn. The cranial vertical angle was measured after drawing a line passing through the tragus and the 7th cervical spinous process. The cranial vertical angle was determined as the angle formed between the horizontal line passing through the 7th cervical spinous process and the line connecting tragus of ear and the 7th cervical spinous process. A previous study argued that a smaller cranial vertical angle results in greater forward projection of forward head[6] (Fig. 1).

Tetrax Portable Multiple System (Tetrax Ltd, 56 Miryam Ramat Gan, Sunlight, Israil) was used to measure the static balance of subjects. Tetrax has two mobile force plates (12×30 cm each), and posture disturbance is evaluated by change in weight (34 Hz sampling rate) on four points (left and right toes and heels), from which the stability test index (STI), and index of static balance, is computed[9]. Each measurement, lasted for 30 seconds and a rest time of 20 seconds was given between measurement[15]. Static balance was measured on stable and unstable surfaces with the eyes open, and closed. The stability test index is computed by calculating the center of gravity and rate of change in the center of pressure on the front and rear of the force plate[9]. A high stability test index indicates greater postural sway, and a low STI indicates smaller postural sway[16].

Subjects were measured for range of motion in dorsiflexion and plantarflexion of both ankle joints in order to evaluate the transmission of tension in the extension muscles of the neck caused by forward head posture. To measure the range of motion of dorsiflexion and plantarflexion of the ankle joints, a distal joint range of motion measurer Distal dualer-IQ (JTECH Medical, USA) was used, and three measurements in the supine position were averaged.

Data collected in this study were statistically analyzed using SPSS 17.0 for Windows. Means and standard deviations were calculated for descriptive statistics, and multiple regression was carried out to examine the effect of the cranial vertical angle on ankle joint range of motion and static balance. A significance level, α, of 0.05 was used.

RESULTS

The 51 subjects (22 males and 29 females) had a mean age of 21.8 ± 2.1 years, a mean height of 166.8 ± 9.7 cm, and a mean body weight of 62.0 ± 12.0 kg. Multiple regression of CVA with static balance, and dorsiflexion and plantarflexion of the ankle joints revealed that an increase in cranial vertical angle resulted in an increase in ankle plantarflexion range of motion ($p<0.05$), but no change in static balance (Table 1).

DISCUSSION

In this study, multiple regression was performed to examine the effect of forward head posture on ankle joint range of motion and static balance. We found that an increase in cranial vertical angle increased ankle plantarflexion range of motion. This means that forward head posture affects normal ankle plantarflexion range of motion. Forward projection of the head results in backward pull of muscles by the fascia, limiting normal ankle plantarflexion range of motion.

Among 11 myofascial meridians summarized by Myers[12], defining connections among human body fascia, the superficial back line connects the gastrocnemius to the hamstrings attached to ischial tuberosity, the sacrotuberous ligament, thoracolumbar fascia, erector spinae, iliocostalis, epicranial, galea aponeurotica, and frontalis muscles, transmitting tension from the back or gastrocnemius to other parts. In this study, a high cranial vertical angle indicated non-projection of the head. Therefore, subjects with high CVA had no tension arising from extension muscles disturbing maintenance of posture. Forward head posture results in reduction of ankle plantarflexion range of motion due to tension of extension muscles in the direction of head. The results of this study show that human body parts have organic relationships involving the fascia which transmit tensions arising from different postures among each other.

Most previous studies of forward head posture have investigated cervical range of motion in headache caused by forward head posture[6)], neck pressure threshold associated with forward head posture[11)], and forward head posture associated with scapular upward rotation[17)].

Since most previous studies have focused on range of motion in the proximal joints and pain arising from forward head posture, this study is the first to attempt to examine the effects of fascia in forward head posture on distal joints, ankle joint range of motion, and static balance.

Forward head posture did not influence static balance. This is probably because overall static balance is good among healthy undergraduates.

This study provides data on the effect of forward head posture on ankle joint range of motion and static balance through transmission of tension along the superficial back line, one of the myofascial meridians. We showed tension in the human body is transmitted by fascia through myofascial meridians with possible influence on the biomechanics of the distal joints. We consider that future studies are necessary on the effect of forward head posture on human body joints and static balance according to age.

REFERENCES

1) Fernández-de-las-Peñas C, Alonso-Blanco C, Cuadrado ML, et al.: Forward head posture and neck mobility in chronic tension-type headache: a blinded, controlled study. Cephalalgia, 2006, 26: 314–319. [Medline] [CrossRef]
2) Fernández-de-las-Peñas C, Cuadrado ML, Pareja JA: Myofascial trigger points, neck mobility, and forward head posture in episodic tension-type headache. Headache, 2007, 47: 662–672. [Medline] [CrossRef]
3) Silva AG, Punt TD, Sharples P, et al.: Head posture and neck pain of chronic nontraumatic origin: a comparison between patients and pain-free persons. Arch Phys Med Rehabil, 2009, 90: 669–674. [Medline] [CrossRef]
4) Yip CH, Chiu TT, Poon AT: The relationship between head posture and severity and disability of patients with neck pain. Man Ther, 2008, 13: 148–154. [Medline] [CrossRef]
5) HwangBo G: Analysis of the change of the neck pressure pain threshold in long term computer users. J Kor Cont Asso, 2008, 8: 151–158. [CrossRef]
6) Chae YW: The effect of forward head posture and cervical ROM on chronic and episodic tension-type headache in university students. J Kor Soc Phys Ther. 2009, 21: 71–77.
7) Berg KO, Maki BE, Williams JI, et al.: Clinical and laboratory measures of postural balance in an elderly population. Arch Phys Med Rehabil, 1992, 73: 1073–1080. [Medline]
8) Fong KN, Chan CC, Au DK: Relationship of motor and cognitive abilities to functional performance in stroke rehabilitation. Brain Inj, 2001, 15: 443–453. [Medline] [CrossRef]
9) Seo DK, Oh DW, Lee SH: Effectiveness of ankle visuoperceptual-feedback training on balance and gait functions in hemiparetic patients. J Kor Soc Phys Ther. 2010, 22: 35–41.
10) Menz HB, Morris ME, Lord SR: Foot and ankle characteristics associated with impaired balance and functional ability in older people. J Gerontol A Biol Sci Med Sci, 2005, 60: 1546–1552. [Medline] [CrossRef]
11) Runge CF, Shupert CL, Horak FB, et al.: Ankle and hip postural strategies defined by joint torques. Gait Posture, 1999, 10: 161–170. [Medline] [CrossRef]
12) Myers TW: Anatomy Train: Myofascial Meridians for Manual and Movement Therapists, 2nd ed. Seoul: Translated by Elsevier Korea LLC, 2010: pp 1–14, 95–123.
13) McDonnell MK, Sahrmann SA, Van Dillen L: A specific exercise program and modification of postural alignment for treatment of cervicogenic headache: a case report. J Orthop Sports Phys Ther, 2005, 35: 3–15. [Medline]
14) Johnson GM: The correlation between surface measurement of head and neck posture and the anatomic position of the upper cervical vertebrae. Spine, 1998, 23: 921–927. [Medline] [CrossRef]
15) Laufer Y, Sivan D, Schwarzmann R, et al.: Standing balance and functional recovery of patients with right and left hemiparesis in the early stages of rehabilitation. Neurorehabil Neural Repair, 2003, 17: 207–213. [Medline] [CrossRef]
16) Karlsson A, Frykberg G: Correlations between force plate measures for assessment of balance. Clin Biomech (Bristol, Avon), 2000, 15: 365–369. [Medline] [CrossRef]
17) Weon JH, Oh JS, Cynn HS, et al.: Influence of forward head posture on scapular upward rotators during isometric shoulder flexion. J Bodyw Mov Ther, 2010, 14: 367–374. [Medline] [CrossRef]