INTRODUCTION

Cervical musculoskeletal disorders have been becoming a global health problem which disturbs an increasing number of people [1]. Cranio-cervical position during computer use can be various due to frequent posture adjustment. Poor postures may give rise to abnormal stress on the muscles and joints leading to the development of cervical musculoskeletal disorders. Several studies based on computational models showed that optimal ergonomic design of workstation could minimize load-carrying along cervical spine [2]. A number of studies through experiment measurement suggested that there was a positive correlation between non-neutral cranio-cervical positions (e.g. neck flexion, neck lateral bending, and forward head posture) and pain syndromes [3, 4]. Although considerable research has been devoted to normal movement of cervical spine, rather less attention has been paid to coupling motion of head and neck. Particularly, biomechanical characteristics of cranio-cervical protraction position are currently lacking. Therefore, the aim of this study is to determine the biomechanical effects of cranio-cervical positions on cervical musculoskeletal disorders.

METHODS

One male adult (Height: 190.3 cm; Weight: 82.2 kg; BMI: 22.6 kg/m²; Age: 23 years old) with an experience of computer operation for 8 hours was recruited in this study. The support forces were measured using two force platforms. Participant was asked to wear lycra pants without T-shirts or shoes, and then to do warming up of head and neck to minimize the effects of tissue creep along the cervical spine. An 8-camera, infrared motion analysis system (Vicon MX, Oxford, UK) was used to capture the three-dimensional posture of seated human. After a set of markers were attached to landmarks, participant was instructed to sit on one force platform and to step on the other one with hips and knees at 90°. The feet positioned shoulder width apart, and arms relaxed at the side of body. This study utilized repeated measure design with participant performing six sitting postures randomly. The six experimental conditions included cranio-cervical neutral position; cranio-cervical protraction; and cranio-cervical flexion. Finally all these three conditions were repeated with upright and slump sitting postures.

A generic human model with detailed neck was established using AnyBody Modelling System. The size of the model was scaled according to the participant’s anthropometry. The kinematic data from motion capture was used to drive various motions. The model can calculate joint and muscle forces under each experimental condition. A preliminary model validation was performed by comparing the simulated muscle force of trapezius and muscle activity measured by electromyography.

PRELIMINARY RESULTS AND DISCUSSION

There were obvious differences in muscle recruitment among three cranio-cervical positions with upright and slump sitting postures (Figure 1 and Figure 2). For cranio-cervical protraction, trapezius-scapular muscle during slump generated 46% more force than that during upright sitting. While trapezius-clavicular muscle force was 1.5 times greater than that in upright sitting. Trapezius-scapular muscle in protraction generated 15% more force than that in flexion and neutral position in both upright and slump sitting. Moreover,
this type of superficial muscle shared more load than other parts.

In order to examine the validity of the simulation, a comparison of trapezius muscles between the simulation results and EMG envelope was performed (Figure 3). From the EMG, trapezius muscles became more active in slump than in upright sitting. This finding can be seen in the simulation, indicating that three cranio-cervical positions with slump sitting required more muscle forces than that with upright sitting.

CONCLUSIONS

Our model simulated three cranio-cervical positions under two major sitting conditions which are commonly adopted during high-tech devices use. These results showed the static behavior of cervical spine as different types of load act on the muscles. It was concluded that extensor muscles including trapezius and multifidus muscles played an important part in maintaining cranio-cervical positions, especially for protraction position. Moreover, superficial muscles were found to be more responsive to positional changes of head and neck than deep muscles. This work may provide insight into understanding the mechanism of cervical musculoskeletal disorders caused by cranio-cervical positions.

REFERENCES