Biomechanics of stress of the cervical spine due to use of smartphones

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Abstract

It is known that repeated or prolonged use of smart phones act as one of the risk factors in neck pain. The aim of this study is therefore to develop a computer model of the musculoskeletal cervical spine, which would allow to quantify the influence of flexion of the head, neck, torso on individual cervical vertebra.

Keywords: Cervical spine; Text neck; Musculoskeletal model

1.Introduction

Repetitive or prolonged using a smartphone is known as one of risk factors for pain symptoms in the neck [1]. These symptoms are used to be described by term "text neck". Lee et al, 2015 showed, that participants of clinical study maintained head flexion of 33-45° (50th percentile angle) from vertical when using the smartphone. Hansraj, 2014 used finite element model to estimate neck load. However, the model of Hansraj, 2014 does not assess load at various levels of cervical spine. Further, the neck flexion is considered without taking into account whole posture, namely torso flexion. Therefore, the aim of this study is to develop computational model of the neck, that would allow to quantify effect of head, neck and torso flexion at various levels of cervical spine.

2.Methods

The geometry of musculoskeletal model is based on work of Vasavada, 1998. The unilateral model was imported into OpenSim and contralateral muscles were created by considering symmetry in the sagittal plane. The model contains 60 musculoskeletal units. The model has 8 rotational DOF, where following motion were adopted: head flexion-extension and axial rotation at atlanto-occipital joint (skull to C1), neck flexion-extension, axial rotation and lateral bending (C2 to T1) and torso flexion-extension, axial rotation and lateral bending (T1). Motion of each vertebra was defined as a percentage of total motion of the neck [3]. The mass of head is 4.1kg, the masses of cervical vertebrae are neglected. The overall loading is estimated by calculation of intersegmental moments acting at the levels of cervical vertebrae centers. The load is estimated for head flexion, head flexion combined with neck flexion and flexion of head, neck and torso. Values are intersegmental moment are calculated for all flexion angles equal to 30°.

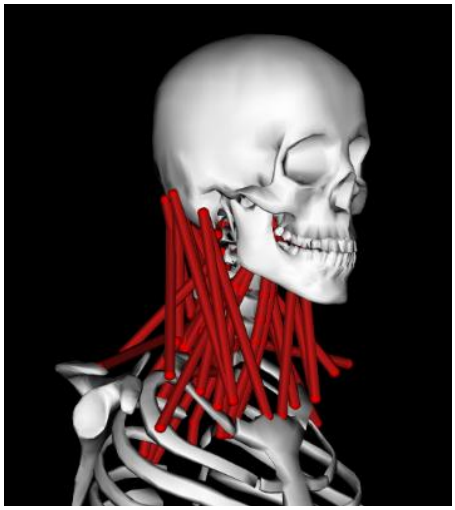

Figure 1: *Musculoskeletal model*

3.Results

The load is increased from C1 to C7 level. Head flexion and neck flexion increases the load as predicted by Hansraj, 2014. However, the most decisive in the level of cervical load is the torso flexion. Torso flexion by 30° can more than double cervical spine load.

4.Discussion

Presented results does not involve active muscle contributions to neck load, that could be even higher than the effect of gravitational forces. Therefore, the model will be further developed by including inverse dynamics calculation including tendon characteristics of cervical spine.

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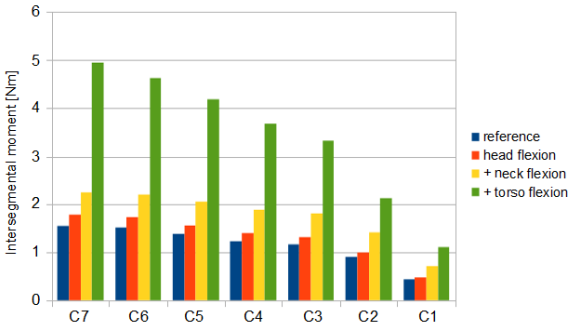

Figure 2: *Cervical spine load estimated by intersegmental moments for various angles of head flexion, head flexion combined with neck flexion and flexion of head, neck and torso.*

5.Conclusion

It could be concluded that text neck may not be caused by neck flexion solely, but it is also an effect of poor posture when using handheld devices.

Acknowledgements

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