Introduction:
Computational models have many advantages in biomechanical analysis. Specifically, we are interested in the role of neck muscles in whiplash injury. Studies have shown that females are more likely to experience whiplash injury than males. A female neck musculoskeletal model is essential for analyzing the gender difference in whiplash. The goal of this study is to develop a biomechanical model of the female head and neck system in SIMM (Software for Interactive Musculoskeletal Modeling; Motion Analysis, Santa Rosa, CA) based upon female anatomy from the National Library of Medicine’s Visible Human Project (VHP).

Methods:
The biomechanical model of the musculoskeletal system in SIMM consists of the following components: skeletal anatomy, joint kinematics, muscle anatomy and force-generating parameters.

Skeletal anatomy
Computed tomographic (CT) images of the Visible Female (59 yrs old, 1.65 m tall) were obtained from the National Library of Medicine website. Image analysis software (3D-doctor, Able Software, Lexington, MA) was used to segment bone geometry and visualize the 3D models of the skull and each cervical vertebra. (Fig. 1, Fig. 2)

Joint kinematics
The vertebrae from the Visible Female were scanned in the supine posture (lying on the back), which is most likely different from the upright neutral posture. Thus the relative orientations of vertebrae (rotations and translations) needed to be adjusted to correspond to the upright neutral posture.

First the geometric center of each vertebra was defined as their origin and the local axes were adjusted to be parallel to the geometric midlines (Fig 3).

Muscle anatomy and Force-generating parameters
The origin and insertion of each neck muscle were defined according to the same anatomical landmarks as in the male model, and straight lines were used to represent curved muscle paths using MRI data, and performing dynamic analyses to address gender differences in neck injury.

Results and Discussion:
I have developed the biomechanical model of female head and neck system initially (Fig. 5). Future model development involves using Magnetic resonance imaging (MRI) to obtain female neck muscle geometry (volume and path), which allows calculation of muscle force- and moment-generating properties, incorporating curved muscle paths using MRI data, and performing dynamic analyses to address gender differences in neck injury.

References:

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