A COMPLETE AND COHERENT MUSCULO-SKELETAL DATASET FOR THE THORACIC AND CERVICAL REGIONS OF THE HUMAN SPINE

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Introduction

Currently there is no anatomical dataset which enables developing a complete and coherent musculo-skeletal model for the thoracic and cervical regions of the human spine. The lack of coherent musculo-skeletal data requires such models combining data from different anatomical studies, which necessitates scaling between the geometries of the spines and the muscle architectures of the cadavers. As a result, models may result in musculo-skeletal systems that are not anatomically realistic. Therefore, a musculo-skeletal dataset measured from a single body will enable a complete and consistent model of the spine and is, therefore, a better approach for clinical practice [1]. Thus, the aim of this study was to obtain a complete and coherent musculo-skeletal dataset for the cervical and thoracic regions of the human spine.

Methods

We obtained an embalmed body of a 79 years-old male (height: 154 cm, mass: 51 kg). We dissected muscles of the thoracic and cervical regions of the spine from the right side of the body and measured positions of muscle attachments at origin and insertion by using the NDI Hybrid Polaris Spectra tracking system. Prior to dissection, muscles were divided into several muscle-tendon elements to represent their function more accurately. Subsequently, we measured morphological muscle parameters for each element: fiber length, tendon length, sarcomere length, optimal fiber length, pennation angle, mass, and physiological cross-sectional area (PCSA) by using previously described protocols [2, 3].

Results

In total, we measured 39 muscles using 225 muscle elements. All the bones with muscle lines-of-action are shown in Figure 1. Total muscle PCSAs ranged from 0.09 cm^2 for sternothyroid muscle to 14.27 cm^2 for trapezius muscle. Mean sarcomere lengths ranged from 2.10 µm for sternothyroid muscle to 3.91 µm for semispinalis cervicis muscle. Mean optimal fiber lengths ranged from 0.6 cm for rectus capitis lateralis muscle to 14.7 cm for serratus anterior muscle. Mean tendon lengths ranged from 0.4 cm for sternohyoid muscle to 12.3 cm for spinalis thoracis muscle.

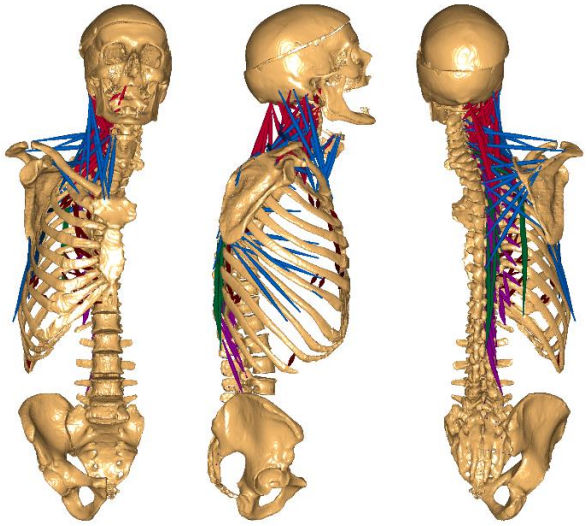

Figure 1: Dissected muscles in the musculo-skeletal system. Muscles of the thoracic spine (green), cervical spine (pale red), thoracic cage (dark red); deep muscles of the spine and ribcage (purple), and muscles connect spine to scapula, clavicle, and sternum.

Discussion

In this study, we obtained a complete and coherent musculo-skeletal dataset for the thoracic and cervical regions of the human spine. This dataset includes segmented bone surfaces (in STL file format), three-dimensional coordinates of muscle attachment sites, and the morphological muscle parameters from a single male human cadaver. Morphological muscle parameters we measured fit with the range of data reported in literature. With this dataset we aim to contribute to an improvement of the state-of-the art in predicting spinal loading. This dataset is freely available through http://www.utwente.nl/ctw/bw/research/projects/TwenteSpineModel.

References

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