ARE LEFT-RIGHT SYMMETRICAL MUSCULO-SKELETAL MODELS REALISTIC?

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ABSTRACT

Musculo-skeletal models enable clinical insights into the normal and pathological functioning of the spine. For example, the effect of thoracic kyphosis on spinal loads and trunk muscle forces can be studied [1]. Generic spine models are usually built by assuming anatomical symmetry between the left and right side of the human body. Therefore, it is critical to verify this assumption when building a model based on an anatomical dataset which was measured from only one side of the human body. In this study, we assess the validity of making a left-right symmetrical model by comparing the architectural parameters for the left and right sternocleidomastoid muscle.

We measured the left and right sternocleidomastoid muscle (SCM) from an embalmed body of a 79 year-old male (height: 154 cm, mass: 51 kg). Prior to dissection, we divided both muscles into four muscle-tendon elements to represent their function more accurately. We dissected the muscles and stored them in 2% formaldehyde solution. Subsequently, we measured architectural muscle parameters: fiber length, tendon length, sarcomere length, optimum fiber length, pennation angle and physiological cross sectional area (PCSA), using the protocols described by Breteler et al. [2]. From each element, we used six to ten samples (single muscle fibers) for sarcomere length measurements with a He-Ne laser using the method of Cross et al. [3].

Although muscle fiber lengths were similar between the left and right, optimum fiber lengths were higher in the left muscle due to lower sarcomere lengths on this side. The total tendon length of the sternal part was also higher in the left SCM. The total PCSAs were 32% and 25% larger on the right side for the sternal and clavicular parts, respectively. These differences imply muscular imbalance for sternocleidomastoid muscle. The discrepancies in PCSAs will cause differences of 47 and 29 Newton in muscle force potentials (assuming a specific muscle tension of 90 N/cm^2). Erroneous force predictions will develop in models if the presented differences are neglected. Although we measured one muscle in this study, similar-anatomical variations are anticipated for other muscles of the spine.

REFERENCES

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