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COMPUTATIONAL MODELING OF MUSCLE CONTRACTURE

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Skeletal muscle muscle adapts to changes in its mechanical environment. Changes in the amount of stretch lead to changes in the serial sarcomere number. The deposition and resorption of sarcomeres is essential for maintaining the sarcomere length at an optimal length for muscle function. Muscle contracture and growth have been well studied on molecular, tissue, and organ levels. However, to date there are no models to bridge the scales.

Here we introduce a multi-scale model based on the framework of continuum mechanics to model muscle adaptation. We calibrated our model using empirical data of mice adapting to shortened tibialis anterior muscle lengths after retinaculum transection. To demonstrate its features, we implemented our model into a commercial finite element software package. Furthermore, using a patient specific lower limb geometry, we simulated the sarcomere loss in gastrocnemius muscle as a result of wearing high-heeled footwear. Our results demonstrate the value of continuum mechanics for predictive modeling in a clinical setting.

We anticipate our model to facilitate a deeper understanding of muscle growth and remodeling. For example, the impact of changes at the micro scale on the macro scale could be quickly tested in silico. Furthermore, muscle contracture is closely linked to cerebral palsy and a computational model would benefit treatment planning.

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