Novel Method for Strain Transfer Research on Murine Flexor Tendons at Cellular Level

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Tendinopathy is a highly prevalent clinical condition mainly caused by overuse or age-related degeneration of tissues. The transfer of strain from the ECM to the cell triggers extracellular matrix (ECM) remodeling. Therefore, a reduction in strain transfer could lead to a reduction in ECM remodeling and ultimately, tissue degeneration. A bioreactor with the capabilities of applying controlled loads and imaging loaded tissues would enable the study of strain transfer at the cellular level. The team inherited previously established hardware for a customized mechanical loading bioreactor, which has the potential to be used in conjunction with the Olympus FV3000 confocal microscope. The team developed two custom programs using MATLAB App Designer to control the bioreactor and analyze data. The control software performs customized experiments (Manual Movement, Imaging Protocol, and Cyclic Movement), provides real-time data of relative position of the slider and applied load on the sample, and saves data to an Excel file for further analysis. The data analysis software uses image processing and tissue-level displacement data to calculate multi-scale strains and strain transfers. Depending on the structure(s) stained in the confocal images, the software has the ability to calculate ECM-, cell-, and nucleus-level strains as well as strain transfers from tissue to ECM, ECM to cell, and cell to nucleus. Additionally, the team developed a research protocol for a future age-related experiment, which would allow Dr. Connizzo to observe strain transfer via simultaneous mechanical loading and fluorescence imaging on aged live murine flexor tendons.

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