Net Flux and Chill – Mathematical modelling of tendon

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Tendons are made up of bundles or fascicles of roughly cylindrical collagen fibrils. In initial mechanical modelling of tendon, this is how they were modelled, as a homogenous array of elastic/viscoelastic rods under stress.

However, this neglects certain key facts about the tissue. Subsequent modelling has progressed to account for the fibril crimp and the extrafibrillar matrix. However, very few of them account for the effects of fluid flow within the tendon, and none make use of direct microstructure measurements.

We develop a new method for modelling tendon mechanics directly from 3D scanning electron microscopy microscale images, incorporating an automated fibril tracking algorithm as well as the mechanical response and flow of extrafibrillar fluid.

From this we can examine and attempt to explain circadian variations in tendon microstructure and mechanical response that have been recently discovered in Chang et al (2020) NCB, where the distributions of fibril size was shown to significantly vary over 24 hours, and the stress-strain response also changed through the day. We hypothesise that the changes in fibril microstructure contributes to the change in mechanical response.