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Unravelling the mechanical properties of collagen with centrifuge force microscopy

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Collagen is the most abundant protein in vertebrates and plays a crucial role for the integrity of stress-bearing tissues, such as tendon and cartilage. All collagen types consist of three α chains, which are coiled about each other into a right-handed triple helix. It is well known that *in vivo* collagens'mechanical properties provide stability and structure to tissues under a wide range of forces. However, a clear understanding of collagen's mechanics on the molecular level is still missing. Force-dependent collagen experiments at the molecular level have generally employed magnetic or optical tweezers or atomic force microscopy, costly techniques that are generally low-throughput. The centrifuge force microscope (CFM) that we use for force-dependent structural studies helps to surmount these issues [1]. The CFM enables high-throughput single-molecule stretching experiments for force-dependent structural studies on an ensemble of objects using centrifugal force. Our system consists of a miniature light microscope mounted within a rotating device like a centrifuge bucket, with temperature control, live video, long run times (> 2 hours) and a low build cost (< $1000) . Our approach is answering the central question of how an applied force affects the quaternary structure of collagen. Unraveling the mechanical properties of collagen will then help to determine structural and mechanical aberrations associated with collagenopathies and to elucidate how mutations may change collagens'behaviour under force.

[1] Kirkness MWH, Forde NR. Single-Molecule Assay for Proteolytic Susceptibility: Force-Induced Collagen Destabilization. Biophys J. 2018;114(3):570-576.

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