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Abstracts

Load Bearing Properties of Cartilage

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Articular cartilage is a connective tissue that provides many important biological functions among which load bearing and lubrication are the most noteworthy. Collagen is the major component of cartilage extracellular matrix (ECM), which provides mechanical integrity for the tissue. Cartilage matrix is produced by chondrocytes (cartilage cells) which are distributed throughout the ECM. Although recent research has elucidated much about the biochemical and genetic alterations associated with cartilage degeneration, advances in understanding the effect of molecular and ultrastructural changes on the biological function of cartilage are hindered by the limited knowledge of the interactions among the constituents of the ECM in normal and diseased states. Such knowledge is critical, because the nanoscale structure is one of the key factors governing cartilage biomechanical function.

Recent advances in nanotechnology made it possible to study cartilage structure and biomechanical properties at high resolution. The techniques we are using include nanoindentation by the atomic force microscopy, small angle scattering methods (SAXS, SANS, neutron spin-echo), osmotic stress measurements, tissue micro-osmometry, etc. We have developed a tissue micro-osmometer (TMO) which is capable to determine the osmotic response of very small < 1 μm tissue specimens. The combination of AFM nanoindentation and tissue micro-osmometry makes it possible to create osmotic modulus maps of cartilage. The osmotic modulus defines the resistance of the tissue to external load. We will discuss important technical considerations and potential applications of these novel techniques and approaches.