Examining the Mechanical Properties of Collagen

The healing of ligaments following traumatic injuries is often less than optimal. The effect of angiogenesis, or the growth of blood vessels, on ligament healing is believed to be important, but this phenomena is not well understood, primarily due to a lack of experimental in vitro and in vivo studies. As a step toward understanding the effects of angiogenesis on the material properties of the collagenous extracellular matrix, the objectives of this work were to develop and validate an experimental test device for the material characterization of collagen gels used for in vitro culture of vascular fragments.

Through preliminary testing of collagen gels, shortcomings of the test system were realized. It was determined that a new experimental setup was needed. Requirements of the test device included ability to apply sinusoidal strain profiles at various frequencies and amplitudes, a method for measuring forces exerted by the collagen without significant external interference, and ease of interfacing the delicate gels was developed to meet these requirements.

This novel system entails the use of a piezo-actuated translation stage. The sinusoidal signal is produced by a function generator, amplified and then used to excite the piezoelectric actuator at various frequencies and amplitudes to achieve the desired sinusoidal strain profiles. The collagen gels are polymerized in custom designed chambers and are placed on the stage for material characterization. The resistive forces of the collagen are measured with a sensitive load cell and the data is collected and analyzed with a computer.

This novel system will allow the mechanical properties of collagen to be characterized. Future work will include examination of the effects of angiogenesis on collagen properties and eventually a heightened understanding of how angiogenesis affects the healing of torn ligaments. This work will lead to an improved understanding of the role of angiogenesis in ligament healing, and for the study of extracellular matrix