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In Vivo Biomechanical Measurements Using Vibrational Optical Coherence Tomography

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Abstract: Vibrational Optical Coherence Tomography (VOCT) is new technique capable of noninvasively and nondestructively measuring the biomechanical properties of tissues *in vivo*. The technology utilizes audible sound combined with infra-red light applied transversely to the tissue surface to obtain the resonant frequencies of both the cellular and extracellular components of tissue. The measured value of the resonant frequency is related to the elastic modulus and the sample dimensions. The technique is calibrated by making *in vitro* measurements of the Young's modulus using uniaxial tensile experiments on the same samples used to make VOCT measurements. In this presentation we describe the details of the experiments used to make vibrational modulus measurements on a number of tissues both *in vitro* and *in vivo*. Experimental calibration measurements made using VOCT indicate that the stiffness measured is proportional to the tensile modulus and that at the resonant frequency the behavior is almost perfectly elastic. These measurements lead to the determination of the relationship between resonant frequency squared divided by the tissue thickness and the elastic modulus.

The results of experimental measurements made using VOCT on tissues *in vitro* and *in vivo* indicate that the resonant frequency of cellular tissues including porcine fat and Staph Aureus biofilm is about 40 Hz and the collagenous resonant frequency is about 90 Hz in normal skin. In comparison, the resonant frequency of collagen in healed scar increases to about 220 Hz. This increase in resonant frequency is associated with the deposition of aligned collagen fibers in scar tissue. Studies on benign skin lesions indicate that the resonant frequency of the epidermis is about 40 Hz and the peak is very sharp compared to measurements on malignant lesions which have higher resonant frequencies and broader peaks.

VOCT measurements have been conducted on a variety of skin lesions, ocular tissues, cartilage, subchondral bone and vascular tissues and will be the subject of other presentations.

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