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Virtual biopsies of tissues and carcinomas using vibrational optical coherence tomography

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Vibrational optical coherence tomography (VOCT) is a new technique that combines the imaging power of optical coherence tomography with the use of sound to characterize the physical properties of tissues. This technique has been developed to perform "virtual" biopsies and biomechanical measurements on normal and malignant tissues non-invasively and non-destructively. It has been previously reported that cutaneous wound healing and the development of malignant skin lesions are associated with changes in tissue stiffness. VOCT produces images of groups of cells as well as biomechanical information in three dimensions that can distinguish normal from pathological tissue. In addition, the biomechanical properties of the tissue margins can be characterized. The images and the biomechanical data from measurements made on different skin lesions and carcinomas together can help plan surgical interventions and monitor the healing process of skin lesions. VOCT produces images of groups of cells as well as measurement of the tissue resonant frequency in three dimensions which assists in distinguishing normal from pathological tissue.

We have imaged and studied several types of skin lesions including a BCC, SCC Actinic Keratosis and a Nevi using VOCT to evaluate the morphology, stiffness, depth and margins of these structures. While cellular components present in skin and carcinomas have resonant frequencies in the range of 30 to 60 Hz, normal collagen has a resonant frequency in the range greater than 90 Hz. In comparison, fibrotic collagen is shown to have resonant frequencies above 150 Hz as does collagen from skin lesions.

It is concluded that the ratio of the resonant frequency squared to the tissue thickness obtained from VOCT can be used to grade the type of tissue response seen. Further studies are underway to establish the relationship between tissue stiffness and lesion morphology for cellular and fibrotic lesions based on the characteristic ratios of resonant frequency and tissue thickness.

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