Noninvasive Assessment of Articular Cartilage Using Quantitative Optical Techniques

Articular surface damage occurs to cartilage during normal aging, osteoarthritis, and in trauma. Noninvasive assessment of cartilage microstructural alterations resulting from normal and pathologic processes is useful for studies involving animal models of orthopedic pathology and surgical repair, in vitro studies of cartilage biomechanics, and perhaps eventually clinical diagnostics and surgical pre-planning. The current gold-standards for assessment of cartilage are MRI and white-light arthroscopy in vivo, and laser scanning microscopy/tomography and electron microscopy ex vivo. MRI and white-light arthroscopy suffer from relatively poor resolution and contrast, compared to the ex vivo techniques. On the other hand, laser scanning techniques may require relatively expensive equipment, or subject cartilage to high laser fluence that alters chondrocyte behavior. Processing for electron microscopy renders cartilage non-viable. Therefore, there is a need for an assessment tool sensitive to the zonal microstructure of articular cartilage, for in vitro studies of living cartilage tissue and with potential translation to the clinic. Quantitative polarized light microscopy (qPLM) is a technique that is sensitive to collagen birefringence, and produces quantitative optical parameter maps from unstained 5-10 µm thick histological sections. Researchers already use qPLM in a semiquantitative way to assess cartilage tissue from animal models of orthopedic pathology. This talk will report on 1) a development of qPLM to large cartilage sections measuring several centimeters across, 2) a microstructural score to quantify alterations from normal, 3) extension of qPLM from thin sections to thick cartilage explants, characterizing surface microstructure using reflectance signals, and 4) a mathematical model that explains the microstructural origins of trends in polarized reflectance from cartilage explants. The results are relevant to the efforts of orthopedic researchers studying mechanobiology-microstructure relationships in different aspects of the normal, pathologic and surgically-repaired knee joint. Future efforts will seek to translate knowledge gained from the present study to microarthroscopy techniques to assess cartilage microstructural alterations and chondrocyte metabolism simultaneously, during orthopedic surgery and surgical pre-planning.

Wednesday, February 1st, 2017 at 4:00pm in 108 Hannan Hall with Refreshments served at 3:45

For more information or if you would like to request disability accommodations, please contact: Patrick Burke (202) 319-5315