CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Matthew-Keane Q. Wang

Project Number

S1313

Project Title

Characterization of the Osteochondral Interface by Digital Volumetric Imaging: A 3-D Study of Osteoarthritis

Abstract

Objectives/Goals

The Osteochondral (OC) interface is composed of the subchondral plate (ScP), the attached articularcartilage (AC), and the calcified cartilage between. Histology has suggested that pores in the ScP are vascular channels or resorption pits, evidence of osteoarthritis (OA) pathogenesis. Previous tests, however, lack sufficient resolution and ability to image in 3-D, which would enable detailed analysis of these features. This study aimed to characterize the OC interface in both normal and OA tissue with Digital Volumetric Imaging (DVI) methods. It is hypothesized that OC interfaces have distinctive features, apparent in DVI, that are distinguishable in OA tissue and indicative of OA pathogenesis.

Methods/Materials

Knee tissue, with three normal (NL) and three clinical OA, were obtained (~4mm3 cube, 50% bone, 50% cartilage around the ScP). Samples were fixed in paraformaldehyde, decalcified in EDTA, stained with Acridine Orange and Eosin Y, and embedded with Spurr resin. Prepared samples were sectioned and imaged through DVI at 10X magnification with a (0.89 μm)3/voxel resolution. The resulting images were processed and then analyzed based on activity, size, and bony cap behavior.

Results

Vascular channels, in addition to the overall structure of the osteochondral interface, were clearly delineated in DVI. Despite similar overall quantity of vascular channels, the OA sample exhibited higher ratio of active to inactive channels, higher incidence of missing/open bony caps, and greater penetration of vascular channels compared to normal osteochondral tissue.

Conclusions/Discussion

This study, with procedures designed and performed by the author and under the surveillance of lab supervisors, elucidates the structural changes in the osteochondral interface that occur during the pathogenesis of osteoarthritis. With 3-D, features such as vascular channels are visible that were previously omitted in 2-D staining methods. With a structural backbone and well-developed understanding of osteoarthritis development, treatments for progressing OA can be pursued.

Summary Statement

This study elucidates the structural changes in the osteochondral interface that occur during the pathogenesis of osteoarthritis through the use of novel imaging techniques and methods.

Help Received

Van W. Wong provided safety training as well as training in standard operating procedures. Neil Chang provided assistance with the Digital Volumetric Imaging machine, and Robert L. Sah facilitated the project as the head of the lab.