Thickness and material properties of normal versus osteoarthritic cartilage In humeral heads

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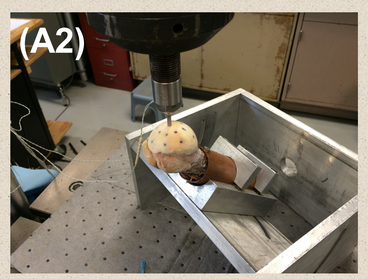
Background

The purpose of this ongoing project is to quantify spatial variation of human humeral head articular cartilage thickness and biomechanical properties (aggregate modulus and permeability) for a range of clinically normal and osteoarthritic shoulder joints. The long term goal of this project is to develop and validate a new testing method which is capable of quantifying early changes in cartilage thickness and/or material properties associated with the development of clinical osteoarthritis. Normal and clinically osteoarthritic humeral heads from human patients are tested for differences in thickness, aggregate modulus and permeability of their overlying articular cartilage. Significant differences, if found, may represent important indicators of the onset of osteoarthritis in clinical human and/or animal patients.

Methods

Human humerii, acquired from a tissue bank are mapped and plotted with 17 points across their articular surfaces (Fig B1, C1). Cartilage thickness was determined through a needle probe test (Fig A1) in which a 22g needle is advanced at a rate of 1mm/min until the subchondral bone is contacted. Stress relaxation testing (load to 20% strain and then held for 120s) is used to determine aggregate modulus and permeability of the cartilage (i.e. material properties of the cartilage) (Fig A2). A custom Matlab curve fitting program is used to extract properties from test data.

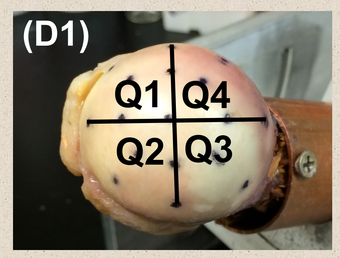


Results

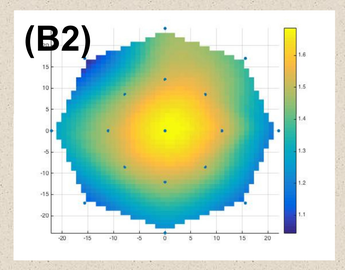
Surface plots of thickness (Fig B2, C2), aggregate modulus (Fig B3, C3), and permeability (Fig B4, C4) indicate the local and regional variation observed between samples. Figures B2-4 represent average values of two clinically normal humeral head surfaces. Figures C2-4 represent data from a patient with osteoarthritis. Additionally, articular surfaces are divided into quadrants (Fig D1), allowing for regional comparison of normal and osteoarthritic articular cartilage. Figures D2-4 compare thickness, aggregate modulus, and permeability in each quadrant for normal and osteoarthritic samples tested.

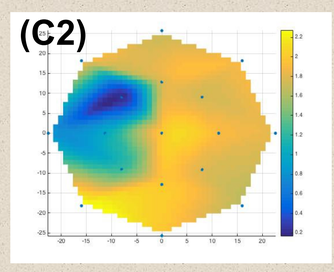
Normal | **Osteoarthritis** | **Quadrant Analysis**

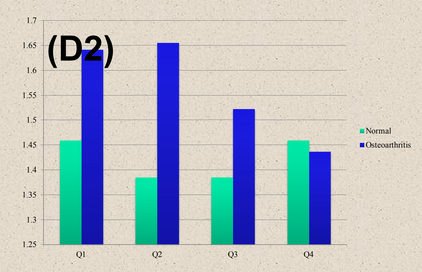
Image of Bone Surface



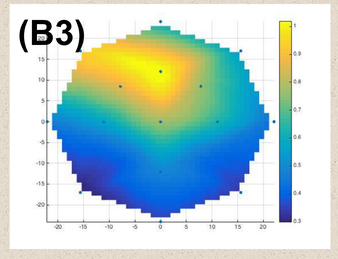
Thickness (mm)

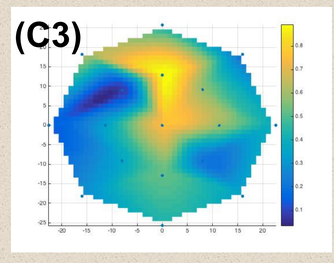


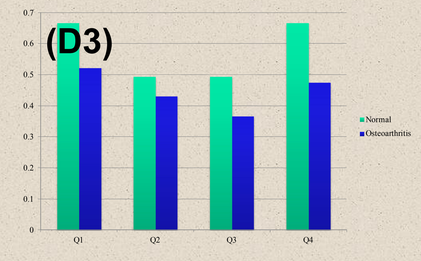




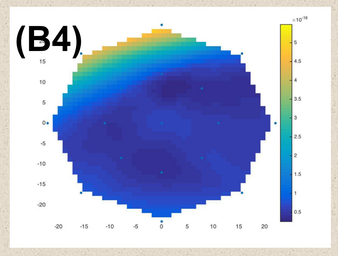
Aggregate Modulus (Mpa)

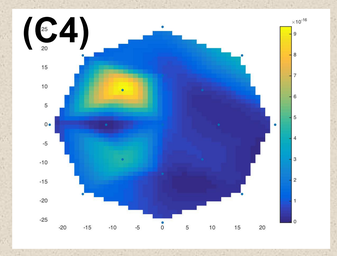


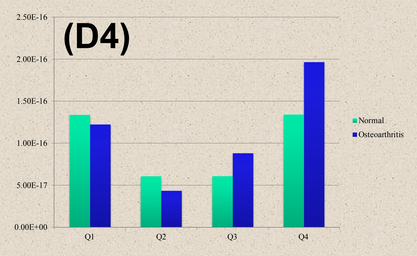




Permeability







Conclusions

Presented is a method to determine humeral head articular cartilage spatial variation in thickness, aggregate modulus, and permeability. A considerable difference in thickness and material properties was measured between normal and osteoarthritic samples indicating that the method used can potentially be used to identify early indicators of osteoarthritis initiation.

Aknowledgements

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