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Indentation Probing of In Vitro Bovine Articular Cartilage: Effects on Chondrocyte Viability and Tissue Biomechanics

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ABSTRACT

Osteoarthritis (OA) consists of a degenerative disease on articular cartilage, which is prone to excessive mechanical loading and frictional resistance that leads to the wear and tear of the tissue. These factors result in the progressive and incurable disease that affects millions of people worldwide. The goal is to characterize chondrocyte viability and the *in vitro* biomechanical properties of articular cartilage in two confined indentation studies. One study looks at the chondrocyte viability over seven days. The second compares the immediate effects of strain rates on chondrocyte viability and tissue biomechanics. Bovine cartilage explants are harvested, cultured, and then 40% strain indentation tests are conducted at the rates of 80% s^{-1} & 0.1% s^{-1} depending on the study. All samples are stained and imaged via confocal microscopy after indentation and twice more during the seven-day study. Tissue micro- and macro-mechanics was assessed by atomic force microscopy and by the indentation test instrument, respectively. At the rate of 80% s^{-1}, chondrocyte viability did not significantly progress over seven days. A statistically significant decrease in chondrocyte viability between 80% s^{-1} & 0.1% s^{-1} was noted along with a statistically significant decrease in the stiffness of the indented area. Cartilage damage propagation over seven days did not occur and cartilage mechanics is dependent on strain rate. For developing a more accurate post-injury OA development model, further biomechanical information needs to be elucidated.

KEYWORDS

Osteoarthritis (OA), Damage Model, Bovine Articular Cartilage, Indentation Probing, Chondrocyte Viability, Tissue Micro- and Macro-Mechanics, Confocal Microscopy, Atomic Force Microscopy