Estimation of compressive stress in articular cartilage using finite element analysis

Oral Presentation

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Abstract
Introduction: Sports participation is associated with an increased risk of osteoarthritis (OA), much of which results from joint injury (1). This study aims to characterize the deformations in articular cartilage under compressive loading and link these deformations to changes in the extracellular matrix with Finite Element Methods (FEM).
Methods: Articular cartilage is an anisotropic, viscoelastic and inhomogeneous material with depth-dependent mechanical properties due to variation in composition and structure of the extracellular matrix. For simplification in Abaqus Software (CAE Standard 2020), elastic behavior was used with young' modulus = 5 MPa and Poisson ratio= 0.46 (2). One of the cartilages was fixed on one side and the other one can move only 3 mm in X direction. There was 2mm distance between two cartilages. Total simulation time was considered to be 2 second. A 4-node bilinear plane element was used for constructing the mesh. It has been assumed that the contact pressure-clearance relationship used to define interaction between two surfaces is a ‘’hard contact’’. This means that no penetration was allowed of the nodes from one surface into the other surface (3).
Results: The greatest Von Mises stress (1.45 MP) was observed at the center of junction of two cartilages and it decreased where further from the contact center (0.363 MP). Therefore, due to the hard contact of the two articular cartilages, stress at the center of the contact surface increased 5 times more than stress at the edges of it.
Conclusion: Using modeling methods such as FEM, it is possible to predict what changes in the structure of articular cartilage will cause improper loads, thus exercise training programs can be changed to prevent sports injuries.

Keywords
Articular Cartilage; Hard contact; Compressive load; FEM

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