**PP-174**

**Direction Dependent Mass Transport Through the Cartilage Endplate**

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INTRODUCTION: Intervertebral Disc (IVD) Degeneration can result from chemical changes in the Cartilage Endplate (CEP) and it might suggest that pain is related to CEP weaknesses and imperfections. The CEP has a crucial role in keeping the IVD healthy by acting as the main gateway of nutrients and waste in and out of that avascular region. Yet, among the spinal tissues, CEPs receive the least amount of attention in scientific literature.
The purpose of this study is to follow a combined in vitro and imaging-driven in silico approach to obtain an improved understanding of the CEP functionality regarding mass transport.
METHODS: In vitro: 6 CEPs were harvested from a fresh bovine tail. Eight mm diameter biopsy samples were prepared and enabled to free swell prior to testing in Dulbecco's Modified Eagle Medium (DMEM). Each sample was fitted tightly into a silicone tube with constant inlet and outlet pressures. DMEM was passed for 10min twice in the forward and reverse direction corresponding to the flow directions into and out of the IVD in vivo respectively. The amount of passed fluid was collected to determine the flow rate.
In silico: The samples were incubated in 40% Hexabrix, a contrast agent, for 48 hours and then imaged by a GE Nanotom® M nanoCT device. From the reconstructed nanoCT images, 1 mm diameter diameter subsamples were selected to create 3D models of the pore structure at different locations in the CEPs. To date, one model was meshed and imported into OpenFOAM® to perform Computational Fluid Dynamics (CFD) Simulations. The other models are still under development.
RESULTS: The in vitro experiment showed that the average flow rate through that CEP samples was 6.86 mm3/sec and 4.84 mm3/sec in the forward and reverse directions respectively meaning that the reverse flow was 70.55% of the forward flow. The CFD analysis on one subsample showed that the flow rates were 15.1 mm3/sec and 10.7 mm3/sec meaning that the reverse flow was 70.86% of the forward flow.
DISCUSSION & CONCLUSIONS: The results from both the in vitro experiment and the in silico simulation showed that the CEP has a tendency to resist flow differently according the direction of the flow where flow into the IVD was higher than that out of the IVD. This combination of image-based in silico modelling with in vitro experiments is a first step towards a better quantification of the mass transport across the CEP in and out of IVDs.

**Keywords:** Cartilage / joint and arthritic conditions, In silico models