MRI-informed Biomimetic Design of Artificial Intervertebral Disc Scaffolds using 3D Bioplotting

E. Hodder, D. Covill, P. Bush, M. Cercignani, N. Dowell, A. Overall, M. Gelinsky, A. Lode, S. Duin

Introduction: Damage to intervertebral discs (IVD's) is a major health concern. However, current artificial disk replacement are associated with an inability to absorb compressive forces and debris release. This investigation aims to address this issue using 3D bioplotting of alginate methylcellulose (alg/MC) with primary bovine articular chondrocytes (pBAC), to replicate native disc tissue. **Methods:** Magnetic resonance imaging (MRI) IVDs provided the dimensions for the alg/MC scaffolds with pBACs (5x106). Cell viability was measured by fluorescent imaging (CMFDA-green and ethidium bromide), and phenotype by PCR gene expression analysis of collagen type I & II, and histological imaging of proteoglycan. Scaffolds were assessed using quantitative (qMRI); T2* for water content, spectroscopy for proteoglycan and MTR for collagen. **Results:** The gene expression ratio of collagen type I to II in 14- day growth samples was 4:96, and mimics freshly isolated chondrocytes (100% collagen II). Safranin-O staining of proteoglycans demonstrated significant increasing content with longer culture time (1,7,14 days). qMRI techniques were successfully applied to achieve measurements of water, collagen, and proteoglycan contents in both healthy disc tissues and day 21 scaffolds. High cell survival of 80% was recorded throughout, and was improved by the variation of print parameters and material sterilisation procedures. **Conclusions:** 3D bioplotting using alg/MC represents a promising new material capable of supporting appropriate chondrocyte phenotype and extracellular matrix synthesis. Mechanical stimulation and testing during growth is the next stage in experiments, to further encourage proteoglycan production and monitor scaffold physical properties.