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The in vitro effect of chondroitin sulfate and glucosamine on tissue-engineered nucleus pulposus

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Nucleus pulposus (NP) is a cartilage-like tissue that locates at the center of an intervertebral disc (IVD) and plays a significant role in maintaining the mechanical function of the IVD. Nucleus pulposus degeneration is the main cause of degenerative IVD diseases (e.g. idiopathic low back pain, sciatica, disc herniation, spinal stenosis, and myelopathy), which lead to billions of dollars in healthcare expenditures each year. The objective of this study is to tissue engineer an injectable construct in vitro to provide a functional (biomechanical and biochemical) alternative to restore the natural function of NP. In this study, Injectable cell-alginate constructs were fabricated by encapsulating NP cells in a 2% w/v alginate solution prior to cross-linking with 0.025 M calcium chloride. Chondroitin sulfate (CS) and glucosamine (GCSN), two chondroprotective supplements, were supplemented to examine their possible role in increasing the mechanical function of the tissue-engineered cell-alginate constructs. A number of GCSN/CS concentrations (125 μg/mL GCSN/100 μg/mL CS, 250 μg/mL GCSN/200 μg/mL CS, and 500 μg/mL GCSN/400 μg/mL CS) in a 5:4 ratio were chosen for the experiment according to their pharmaceutical relevance. Confined compression analysis was performed using an MTS Insight Electromechanical Testing System. Glucosamine and chondroitin sulfate was demonstrated to display dose-dependent increase of the equilibrium confined compression modulus of the supplemented hydrogel with no cells when compared to the non-supplement-control. The addition of cells decreased the modulus of the supplemented constructs initially, but showed a greater increase in modulus over time when compared to the construct with no GCSN/CS treatment. At 125 μg/mL GCSN/100 μg/mL CS, confocal microscopy analysis demonstrated uniform cell distribution throughout the tissue-engineered constructs at day 1, 7 and 14. There were no significant difference in both cell proliferation and viability between the GCSN/CS treated groups and the non-GCSN/CS-treated groups. The results show that GCSN/CS enhances the mechanical function of both the alginate hydrogel and the tissue-engineered constructs. The unique construct with the GCSN/CS supplementation may serve as an injectable application to restore mechanical function of the degenerated disc *in vivo.*

Biography

Ying Deng has completed her Ph.D. in Biomedical Engineering at the age of 28 years from Huazhong University of Science & Technology and postdoctoral studies from Rice University. She is currently working as an assistant professor at the Biomedical Engineering Department of the University of South Dakota. Her research interest is in development of biodegradable scaffolds for intervertebral disc (IVD) tissue engineering. Her laboratory has fabricated a variety of nanofibrous scaffolds to biomimic the nano/micro-fibrous environment of annulus fibrosus of IVD and injectable scaffolds to resemble the gel-like structure of living extracellular matrix in the nucleus pulposus of IVD. She has published more than 20 papers in peer-reviewed journals.

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