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Title of dissertation: Application of 3D bioprinting and development of hydrogel/nanomaterial-based bioinks for meniscal tissue engineering

Abstract: Meniscus tears have a low capacity for self-repair, and none of the available treatments reconstitute the knee function in long-term outcomes entirely. Considering the necessity for novel remedial solutions, the 3D bioprinted implant provides an opportunity to mimic the complex zonal structure of the meniscus and restore its full functionality. The development of bioinks for 3D bioprinting is a pivotal step as its composition and structure affect the phenotype of the developing tissue and strongly influence cell condition and differentiation. Therefore, the primary objective was developing a bioink for extrusion-based 3D bioprinting of meniscal constructs. The concentrations of bioink components (alginate, gelatin, and carboxymethylated cellulose nanocrystals) were based on rheological analysis and printing accuracy. In addition to being printable and durable in cell culture, the bioink is also biocompatible and able to maintain the native phenotype of human knee articular chondrocytes. The encapsulated chondrocytes had viability > 98 % and intensified expression of collagen II after 28 days. Examining the other genes specific to cartilage tissue (*COL1A1*, *COL10A1*, *SOX9,* and *RUNX2*) revealed a decline in transcriptional activity.

Except for the fundamental components of bioink, the dissertation outlines the benefits of multiwalled carbon nanotubes and hyaluronic acid as bioink additives. The rheological and mechanical characterization determined the usefulness of this bioink for cartilage tissue engineering. Carbon nanotube addition nearly doubled the stiffness of constructs, even at concentrations as low as 0.125 mg/ml. For the biological study, human adipose-derived mesenchymal stem cells were mixed with bioink and 3D bioprinted. The combination of both additives had a beneficial influence on cell viability. Expression analysis of *COL1A1*, *COL6A1*, *HIF1A*, *COMP*, *RUNX2*, and *POU5F1* genes revealed significant alterations in their expression, with a general decline in transcriptional activity for most of them.

This dissertation describes the creation of the basic bioink and supplementing it with multiwalled carbon nanotubes and hyaluronic acid. Rheological, mechanical, and biological analysis proves the usefulness of this product in meniscus tissue engineering. Following that, it is reasonable to characterize constructs in long-term culture and undertake *in vivo* studies. Aside from meniscal tissue bioprinting, it is believed that presented results could serve as a basis for the development of bioinks for 3D bioprinting different tissues.

Key words: 3D bioprinting, bioink, meniscus, tissue engineering