Design of 3D Bioprinted Scaffolds for Cartilage Regeneration

G. Pinilla, J.M. Baena, P. Gálvez-Martín, J.A. Marchal

***Abstract*—** Cartilage is a dense connective tissue with limited selfrepair properties. Currently, the therapeutic use of autologous or allogenic chondrocytes makes up an alternative therapy to the pharmacological treatment. The design of a bioprinted 3D cartilage with chondrocytes and biodegradable biomaterials offers a new therapeutic alternative able of bridging the limitations of current therapies in the field. We have developed an enhanced printing processes-Injection Volume Filling (IVF) to increase the viability and survival of the cells when working with high temperature thermoplastics without the limitation of the scaffold geometry in contact with cells. We have demonstrated the viability of the printing process using chondrocytes for cartilage regeneration. This development will accelerate the clinical uptake of the technology and overcomes the current limitation when using thermoplastics as scaffolds. An alginate-based hydrogel combined with human chondrocytes (isolated from osteoarthritis patients) was formulated as bioink-A and the polylactic acid as bioink-B. The bioprinting process was carried out with the REGEMAT V1 bioprinter (Regemat 3D, Granada-Spain) through a IVF. The printing capacity of the bioprinting plus the viability and cell proliferation of bioprinted chondrociytes was evaluated after five weeks by confocal microscopy and Alamar Blue Assay (Biorad). Results showed that the IVF process does not decrease the cell viability of the chondrocytes during the printing process as the cells do not have contact with the thermoplastic at elevated temperatures. The viability and cellular proliferation of the bioprinted artificial 3D cartilage increased after 5 weeks. In conclusion, this study demonstrates the potential use of Regemat V1 for 3D bioprinting of cartilage and the viability of bioprinted chondrocytes in the scaffolds for application in regenerative medicine.

***Keywords*—** cartilage regeneration, chondrocytes, bioprinting, bioinks, scaffolds.

F. A. Author is with the National Institute of Standards and Technology, Boulder, CO 80305 USA (phone: 303-555-5555; fax: 303-555-5555; e-mail: author@ boulder.nist.gov).

S. B. Author, Jr., was with Rice University, Houston, TX 77005 USA. He is now with the Department of Physics, Colorado State University, Fort Collins, CO 80523 USA (e-mail: author@lamar. colostate.edu).

T. C. Author is with the Electrical Engineering Department, University of Colorado, Boulder, CO 80309 USA, on leave from the National Research Institute for Metals, Tsukuba, Japan (e-mail: author@nrim.go.jp).