INSIGHTS ON CELL AND HYDROGEL FLOW BY LIGHT SHEET FLUORESCENCE MICROSCOPY

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Extrusion-based 3D bioprinting is currently the leading additive manufacturing technique for producing cell-laden tissue constructs. Rapid adoption of extrusion-based bioprinting in the biofabrication community is mainly due to its simple concept, the ability to produce constructs at centimetre-scale and the rapid developments in bioinks. Extrusion bioprinting delivers cells embedded in a hydrogel via a nozzle of <500 μm on the printhead. Up to now, the study of bioinks, of their behaviour in the nozzle and their impact on printing and cell viability, relies on rheological measurements and biological assays post printing. When the flow itself is taken into consideration, the research community counts on modelling studies with no experimental data to confirm the theoretical behaviour. Here, we present an investigation employing light sheet florescence microscopy (LSFM) to image and quantify flow of cell-laden hydrogels through a capillary. Gelatine methacryloyl (GelMA), pluronic and agar inks containing cell tracker violet stained-osteosarcoma cell line, SAOS-2 at $1x10^6$ cells/ml concentration was used for extrusion experiments. Quasi-real time images of the flow of the different inks in a capillary of 400 μm internal diameter were acquired of single central planes at a frame rate of 35 Hz with a light time of 6.3 ms. Moreover, 4D dataset of the whole capillaries were recorded showing possible inhomogeneity of the materials. Cells were annotated and tracked to extract velocity profiles and shear rate to quantify flow and fluid behaviour. Our work proves LSFM to be a useful method for the study of bio-materials, by providing novel insights into flow and shear experienced in real time by the cells contained within new generation bio-inks. The experimental observation of hydrogels together with the cells embedded in them flowing through capillaries offered the possibility to enrich what is known about some state of the art materials.