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Formative biofabrication using levitational bioassembly in high magnetic field

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Several research groups recently demonstrated the principal feasibility of magnetic levitational bio-assembly of tissue engineered constructs from living tissue spheroids in the presence of paramagnetic ions. However, Gd3+ is relatively toxic at concentrations above 50 mM used normally to enable magnetic levitation with NdFeB permanent magnets. Using high magnetic field at HFML in Nijmegen, the Netherlands, it was possible to perform magnetic levitational assembly of tissue constructs from living spheroids prepared from SW1353 osteosarcoma cell line with 100 times lower concentration of Gd3+. The assembly of tissue constructs was performed in a 50mm-bore, 30 Tesla Bitter magnet, equipped with mounting for cuvettes filled with culture medium containing spheroids and non-toxic concentrations of Gd3+. The levitation conditions were initially adjusted using 170 µm polystyrene beads. To predict the theoretical possibility of assembly, a zone of stable levitation in the horizontal and vertical area of cross sections was previously calculated. Round-shaped structures from the polystyrene beads and tissue spheroids were assembled at 0.5 and 0.8 mM Gd3+ in 22T and 19T magnetic fields, respectively. The construct from tissue spheroids partially fused after 3 hours of levitation. The analysis of viability after prolonged exposure of strong magnetic field showed the absence of significant cytotoxicity or morphology changes in the tissue spheroids. High magnetic fields works as a temporal and removal support or so-called “scaffield”. Thus, formative bio-fabrication of tissue engineered constructs from tissue spheroids in high magnetic field is a promising research direction.

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