Sound based assembly of spatially organized porous constructs

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INTRODUCTION: An emerging contactless method for creating biologically relevant constructs is acoustic bioassembly. This method induces the assembly of particulate systems through fluid patterns (*e.g.* pressure fields, surface instabilities, waves). These fluid patterns produce hydrodynamic forces that are spatially specific and control the arrangement of micron-sized particles [1]. The frequency and amplitude of the chamber vibrations directly regulate these forces. We decided to exploit this novel technique in combination with cell-laden gelatine beads. We then patterned the beads to generate spatially orchestrated porous constructs where cells can easily invade and proliferate.

EXPERIMENTAL (or Materials and Methods): Gelatine beads (15 % weight / volume) and cell encapsulation were obtained by emulsion process in dextran solution (20 % weight / volume). Adapting the protocol from [2]. A stirring speed of 100 rpm was used to obtain gelatine beads with an average radius of 70 µm and therefore a suitable size for cell encapsulation. Subsequently the beads were spatially organized, in a layer of fibrin solution, through sound-based bioassembly. This final procedure was repeated optimizing a specific set of parameters such as: chamber thickness, chamber dimensions, and frequency applied. Using a circular chamber, we obtained concentric circles as patterns.

RESULTS AND DISCUSSION: The obtained population of beads shown a radius between 50 and 100 µm, an adequate size for encapsulation of cells (d = 10 µm). The encapsulation efficiency obtained was indeed 90 %. Cell viability assay was then performed immediately after encapsulation, showing a promising result of biocompatibility. Furthermore, analysis of the obtained patterns shown a direct correlation between the frequency applied to the system and the complexity of the obtained pattern (number of concentric circles).

CONCLUSIONS: Overall, this could be a suitable method to generate spatially orchestrated porous constructs. In this specific case, we show a proof of concept of cell encapsulation and gelatine beads assembly within fibrin hydrogel. By opportunely loading our sacrificial beads with different cell populations and tuning pattern shape and size, this approach will open the way to create reproducible, shape-defined multicellular systems for biological modelling.

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