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Toward Acoustic Bioprinting: Acoustic Levitation of Tissue Spheroids

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Tissue spheroids are rounded compact cell aggregates with intrinsic capacity for fusion. The fusion of tissue spheroids is a fundamental biological principle of solid scaffold-free bioprinting. Surface acoustic waves could be used for biofabrication of tissue spheroids from the living cells [1]. There are reported attempts of 3D patterning of single cells, cells embedded into hydrogels or plastic beads using acoustic waves [2]. However, acoustic levitation of tissue spheroids has not been reported yet.

We hypothesize that tissue spheroids placed in acoustic field could levitate and form desirable 2D and 3D patterns. In order to test this hypothesis an acoustic device generating standing acoustic waves has been designed. Tissue spheroids have been biofabricated from primary sheep chondrocytes and NIH 3T3 murine line. The suspension of tissue spheroids has been exposed to acoustic waves. Ultrasound pressure levels were well below the cavitation threshold, which guaranteed the absence of mechanical damage. Radiation force exerted on the spheroids was calculated on the basis of the theory developed in [3]. It has been demonstrated that tissue spheroids could be acoustically sorted out based on their size and be patterned into chain-like structures and a series of structures arranged in parallel to each other in 3D space. Tissue spheroids have been viable after exposure to acoustic waves. Closely placed by acoustic waves, tissue spheroids were able to undergo tissue fusion process.

Taken together these data provide proof of principle that 3D patterning of tissue spheroids by acoustic waves is feasible and opens a realistic opportunity for the development of novel acoustic wave-based 3D bioprinter. However, it remains to be seen how principles of acoustic levitation of tissue spheroids will be translated and implemented into a realistic design of novel acoustic 3D bioprinter.

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Keywords: tissue spheroids, acoustic levitation, bioprinting

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