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Characterization of a chip-based bioreactor for three-dimensional cell cultivation via magnetic resonance imaging

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Abstract:

We describe the characterization of a chip-based platform (3D-KITChip) for the three-dimensional cultivation of cells under perfusion conditions via magnetic resonance imaging (MRI). Besides the chip, the microfluidic system is comprised of a bioreactor housing, a medium supply, a pump for generating active flow conditions as well as a gas mixing station. The closed circulation loop is ideally suited for a characterization via MRI since the small bioreactor setup with active perfusion, driven by the pump from outside the coils, not only is completely MRI-compatible but also can be transferred into the magnetic coil of an experimental animal scanner. We have found that the two halves of the chip inside the bioreactor are homogeneously perfused with cell culture medium both with and without cells inside the 3D-KITChip. In addition, the homogeneity of perfusion is nearly independent from the flow rates investigated in this study, and furthermore, the setup shows excellent washout characteristics after spiking with Gadolinium-DOTA which makes it an ideal candidate for drug screening purposes. We, therefore, conclude that the 3D-KITChip is well suited as a platform for high-density three-dimensional cell cultures, especially those requiring a defined medium flow and/or gas supply in a precisely controllable three dimensional environment, like stem cells.

Keywords: 3D-KITChip, MRI, perfusion, homogeneity