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Towards Atherosclerosis-on-a-Chip; A Microfluidic Platform for Anti-Atherosclerotic Drug Screening

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Atherosclerosis is an inflammation-driven chronic disease of the arteries and the leading cause of death worldwide. Therefore, there is a growing need for efficient drug-testing and drug-screening systems. Commonly used drug-testing technologies are based on two-dimensional cell culture systems, which cannot recapitulate in vivo conditions. On the other hand, animal models are not only lengthy and costly, but also poor predictors of human responses. To overcome these shortcomings, we have proposed to use organ-on-a-chip technology for atherosclerotic nanomedicine studies.

We have developed a microfluidic chip consisting of two PDMS layers, separated by a polyester membrane. Each layer has a microfluidic channel, which is capable of simulating the shear condition of a vessel. In addition, endothelial cells were cultured on the membrane and then inflamed to mimic an atherosclerotic vessel. Calcein AM assay was used to investigate cell-viability and morphology of the cells. Moreover, Immunohistochemistry studies and permeation studies were performed. The results of these studies successfully showed tight junctions between cells before inflammation procedure, as well as compromised and leaky junctions after this procedure, which is the main indicator of inflamed vessels. Consequently, the proposed microfluidic chip, which mimics shear condition of a vessel and inflammatory condition of atherosclerosis, is a suitable alternative for typical atherosclerotic drug-screening systems.