Microfluidic kidney-on-chips

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An organ-on-a-chip devices produce levels of tissue and organ functionality not possible with conventional 2D or 3D culture systems. Using microfluidic technology, we successfully established two devices that imitate the microenvironment of renal proximal tubular epithelia to investigate the process of EMT during the development of proteinuric nephropathy. Firstly, we established a “renal interstitium microenviroment-on-a-chip” with human proximal tubular epithelial cells on one side and human umbilical vein endothelial cells on the other. Co-cultures on the chip is superior to conventional culture models for measuring studying renal physiology and kidney diseases. Subsequently, we developed a multifunctional “glomerulus-on-a-chip” (GC) that reconstructs the pivotal structure of glomeruli and realizes glomerular filtration function in a physiologic microenvironment within complex hemodynamic factors, and this device has been used to create a disease model-on-a chip that mimics hypertensive nephropathy in humans. Thus, our study revealed that exposure of renal epithelial cells to flowing medium containing human serum proteins or complement C3a induced apoptosis or a mesenchymal phenotype, providing new insight into this pathological process. It will be developed into robust, predictive models of human physiology and disease, and into tools for drug discovery and development.