

CELL CO-CULTURE MICROFLUIDICS PLATFORM WITH AN INTEGRATED HYDRAULIC VALVE FOR INVESTIGATION OF SIGNAL-MEDIATED INTERACTIONS IN THE BLOOD-BRAIN BARRIER

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ABSTRACT

Lab-on-a-chip systems for real-time analysis of neural cell communication is an emerging topic of neuroscience research that can provide a better understanding of brain functionality. Astrocyte and HBEC-5i co-culture provide *in vitro* model of the blood-brain barrier. The successful employment of lab-on-a-chip cell co-culture devices in research settings requires fabricating materials that are not cytotoxic to the cells. Controlled and reversible separation of cell culture chambers is crucial for real-time studies of extracellular-mediated cell-to-cell communications. This study demonstrated a 3D printed cell co-culture microfluidic platform that enables controlled separation of the chambers and provides the long-term viability of HEBC-5i cells. The platform consists of two 27.5 mm × 35 mm × 10 mm cell culture chambers separated by an Elastic Resin 3D stereolithography printed valve (10 mm × 35 mm × 9.5 mm). The actuation of the valve is controlled using hydraulic pressure exerted by the chamber positioned directly above the valve. The deflection of the valve barrier provides separation of the cell chambers and the individual microenvironments. Upon the release of the pressure, the valve returns to its original position and allows the exchange of signaling molecules between the cells. The lower glass channel wall of the microfluidic device was coated with gelatin, polydopamine (PDA), and poly-L-lysine (PLL) to provide cellular attachment for HBEC-5i cells and astrocytes. The polyelectrolyte immobilization efficacy was assessed via atomic force microscopy while the viability of the HBEC-5i cell was assessed using fluorescent-based methods.

Keywords: Blood-brain barrier (BBB), Microfluidics, Cell co-culture, Astrocytes, HBEC-5i, Atomic force microscopy (AFM), Stereolithography (SLA)

INTRODUCTION

The development of lab-on-a-chip systems for real-time analysis of brain cell communication is an emerging topic of neuroscience research that facilitates *in vitro* studies to understand brain functionality. Astrocytes are major glial cell types in the mammalian brain, that maintain homeostasis and provide nutritional and metabolic support to neurons and the blood-brain barrier [1]. Astrocyte and HBEC-5i co-culture provide *in vitro* models to study the neuronal outgrowth, regeneration, and synaptic plasticity of