Developing microfluidic platforms for anti-thrombotic drugs assessment

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Abstract

Thrombosis is a leading contributor to global disease burden and the use of anti-thrombotic agents is increasing across the population. Traditionally, anti-thrombotic drug evaluation has relied on animal models, which, despite their value, present well-known limitations. Platelet function testing (PFT) is the most promising *in vitro* tool in addressing this clinical need. However, most commercially available PFT systems are bulky, lab-based instruments that fail to replicate physiological flow conditions.

We present a microfluidic platform coated with a protein matrix designed to assess platelet function using whole blood under controlled shear conditions. Fluorescence microscopy enabled real-time visualization of thrombus formation. Three cytoskeletal-targeting drugs—demecolcine, cytochalasin B and paclitaxel—were tested at multiple concentrations in blood from healthy donors. By analyzing image parameters over time, the platform enabled detailed assessment of drug effects. Flow cytometry supported these findings by revealing morphological changes in platelet populations. Cytoskeletal inhibitors reduced thrombus formation, while paclitaxel promoted aggregation, indicating distinct functional impacts.

To advance towards a rapid, real-time and label-free PFT platform, gold interdigitated microelectrodes were integrated at the base of the microchannels. Electrical impedance, varying proportionally with cellular accumulation between electrodes, served as a readout of aggregation. Aggregation was induced by adding the agonist (ADP or collagen) directly into the blood sample, without having any coating inside the channel. The impedance variation was compared to metrics derived from fluorescence image analysis.

Overall, this work demonstrates the power of microfluidic tools to evaluate platelet responses and drug efficacy under physiological flow conditions, supporting a shift toward more ethical, relevant, and reproducible methods in antithrombotic drug research.

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