Microfluidic tools for mechanical screening of circulating cells

Microfluidic Tools for Mechanical Screening of Circulating Cells

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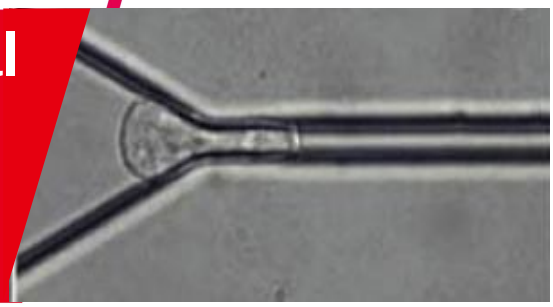


Introduction

Atherosclerosis represents a major risk factor for many cardiovascular diseases (CVD). At this date it is not possible to diagnose patients that hide “unstable vulnerable plaques” due to lack of biomarkers with strong positive predictive values that are able to identify patients with high risk of developing the disease.

One explored avenue for biomarker searching has been the circulating cells (e.g. white blood cells) in the blood. Importantly, when in contact with an injured endothelium or atherosclerotic plaque, circulating cells become activated and alter their mechanical properties and expression patterns[1,2].

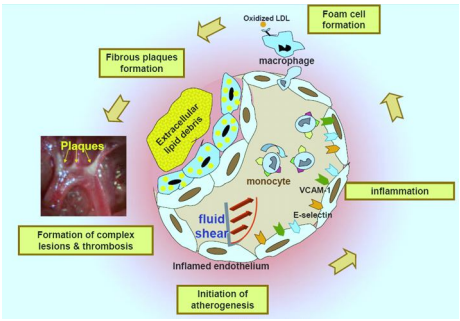


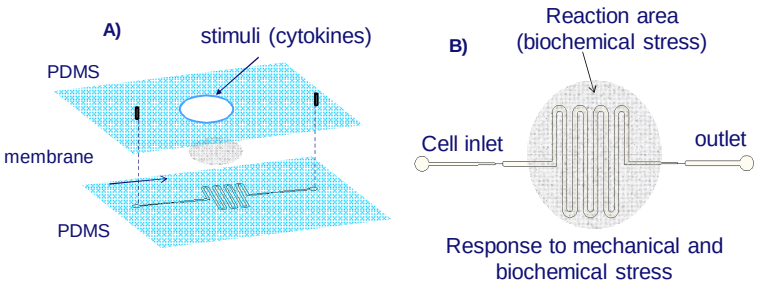
Figure 1. Development of atherosclerosis.

Objective

To develop microfluidic-based devices that allow high throughput mechanical screening and investigation of circulating cells and their potential as carriers of biomarkers suitable for discriminating patients with early stage atherosclerosis or with increased risk of developing multiple unstable plaques.

Designs and Fabrication

Design 1



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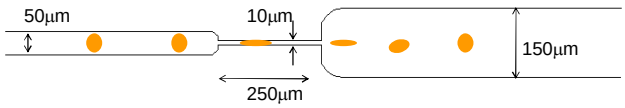

Figure 2. A. Schematic view of a 3-D microfluidic device assembly. 2 PDMS chips are sandwiched together with a polycarbonate membrane (pore size 0.2µm diameter) in between. The bottom layer contains the microfluidic channels and the top layer contains an open reservoir that allows easy introduction of different stimuli.
B. Top view of the microfluidic channel with membrane on top. The design consists of 2 contraction channels (6µm diameters) for mechanical interogation of the cells and a serpentine segment that allows for the incubation and increased reaction time with the applied stimuli on top.
C. Skematic representation of the microfluidic contraction channel for cell defomation studies.

Design 2

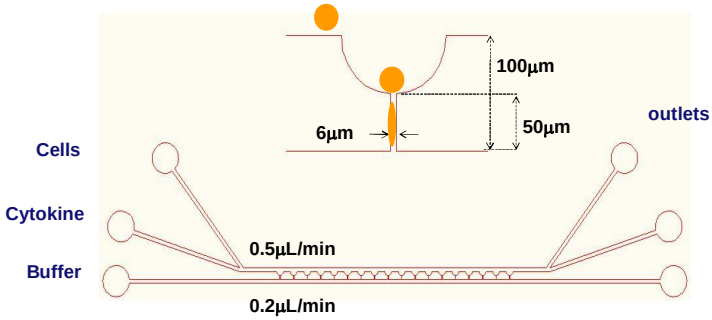

Figure 3. Multi functional microfluidic device for single cell isolation [2], cultivation, mechanical deformation (in the narrow channel that connects the main channel pockets with the buffer channel), chemotaxis and sorting.

Relevant Output

- Cell transit time in the narrow channels
- Cell shape recovery time before and after treatment with various stimuli
- Pre-screening based on subsequent deformation and recovery time cycles of single cells from a pool of cells

References

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3. Y. Yamaguchia, T. Arakawab,d, N. Takedac, Y. Edagawaa, S. Shojib, Sensors and Actuators B: Chemical, 136 (2009) 555–561