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Study of Mixing Conditions for Different Endothelial Dysfunction in Arteriosclerosis

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Abstract : In this work, we studied the microscale interaction of foreign substances with blood inside an artificial transparent artery system that represents medium and small muscular arteries. This artery system had channels ranging from 75 µm to 930 µm and was fabricated using glass and transparent polymer blends like Phenylbis(2,4,6-trimethylbenzoyl) phosphine oxide, Poly(ethylene glycol) and PDMS in order to be monitored in real time. The setup was performed using a computer controlled precision micropump and a high resolution optical microscope capable of tracking fluids at fast capture. Observation and analysis were performed using a real time software that reconstructs the fluid dynamics determining the flux velocity, injection dependency, turbulence and rheology. All experiments were carried out with fully computer controlled equipment. Interactions between substances like water, serum (0.9% sodium chloride and electrolyte with a ratio of 4 ppm) and blood cells were studied at microscale as high as 400nm of resolution and the analysis was performed using a frame-by-frame observation and HD-video capture. These observations lead us to understand the fluid and mixing behavior of the interest substance in the blood stream and to shed a light on the use of implantable devices for drug delivery at arteries with different Endothelial dysfunction. Several substances were tested using the artificial artery system. Initially, Milli-Q water was used as a control substance for the study of the basic fluid dynamics of the artificial artery system. However, serum and other low viscous substances were pumped into the system with the presence of other liquids to study the mixing profiles and behaviors. Finally, mammal blood was used for the final test while serum was injected. Different flow conditions, pumping rates, and time rates were evaluated for the determination of the optimal mixing conditions. Our results suggested the use of a very fine controlled microinjection for better mixing profiles with and approximately rate of 135.000 µm3/s for the administration of drugs inside arteries.

Keywords : artificial artery, drug delivery, microfluidics dynamics, arteriosclerosis
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