Real-Time Microfluidic Evaluation of Hemostatic Properties of Procoagulant Synthetic Platelets

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Excessive traumatic hemorrhage is the leading cause of mortality for civilians and military personnel under 50 years of age. The current treatment of donor derived platelet transfusions is riddled with problems such as short shelf life of 5-7 days, limited availability and portability, and risk of bacterial contamination. To this end, procoagulant synthetic platelets (P-SP) have been designed to improve upon such challenges by mimicking the adhesion, aggregation, and coagulation amplification functions of natural platelets. For coagulation amplification, P-SP membranes contain a pro-coagulant anionic phospholipid phosphatidylserine (PS), as well as an enzyme-sensitive masking system to prevent off-target systemic effects. At the wound site, the enzyme Plasmin is upregulated and thus able to remove the mask upon P-SP aggregation, promoting coagulation with thrombin amplification and enhanced generation of fibrin from fibrinogen. To evaluate the masking system and PS exposure, microfluidic channels were coated with streptavidin, a protein purified from the bacterium Streptomyces avidinii with high binding affinity for biotin. Particles with and without biotin were flowed over the surface to optimize coating and incubation procedures. Biotinylated P-SP immobilized on the streptavidin surface were stained for PS exposure with and without plasmin to test the masking system in an environment mimicking the dynamic flow in the human body. Human blood without platelets was also flowed through the microfluidic channels to test the potential capabilities of P-SP as a platelet substitute. The results suggest that the technology can function in human blood vessels to act as a surrogate for human platelets in hemostasis and can be further developed to combat excess hemorrhage.

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