Novel Method of Circulating Prostate Tumor Cell Separation Using Adhesion Rolling in a Micropatterned, Microfluidic Device

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Tumor-shed cells from an epithelial lining lesion, or circulating tumor cells (CTCs), have been of significant concern with its highly characteristic identification and origin in metastatic diseases. CTCs can provide an insightful guide on detection, monitoring, diagnosis, and analysis of epithelial carcinomas. However, its rarity is a pressing issue. This project creates a new and more effective approach towards the isolation of circulating tumor cells. Based on previous research showing WBC's interaction with the adhesion molecule E-selectin, substrates with immobilized E-selectin antibodies may induce different adhesion forces on CTCs, which have similar properties to WBCs. The WBCs and cancer cells will reveal cell rolling on the E-selectin surface; however, the specific strength of the bond is not known. In this study, preliminary trials of WBCs, CTCs, and RBCs were flowed through a simple, plain device coated with E-selectin. In a 10 µg/ml density, at a shear rate of 80/s, the WBC velocity was 6.12 µm/s, compared to the faster CTC's velocity at 14.53 µm/s. In 5 µg/ml, at the same 80/s shear rate, the WBC's velocity was 11.73 µm/s and the CTC's was 15.84 µm/s. Red blood cells and the plasma had no interaction. The results indicated different rolling velocities between CTCs and WBCs. Thus, the CTCs could be completely separated from the whole blood by designing a microfluidic device with geometric parameters (grooves). Groove inclination will allow each type of cell to follow different pathways. Approximately 75% of CTCs were separated in a single tube, and the purity was nearly 90%. The results open a new and more efficient technique for CTC separation. Cell-specific isolation can be achieved by inclined 3-dimensional patterns simulating cell rolling on E-selectin.

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