Developing a Nanoscale DLD Array Using Immunosignature-Derived Aptamers to Effectively Separate and Analyze Tumor Exosomes

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Current patient disease diagnosis relies on observed symptoms rather than specific genetic information, resulting in low objective response rates as well as expensive and ineffective treatment options. Clinical research has isolated the role of nanoscale particles, exosomes, that are released by virtually all cells and contain that cell's DNA, RNA, and protein information. Evidently, tumor-derived exosomes contain tumor-specific genetic information, making analysis crucial to providing new insight regarding tumors. Effectively separating and purifying exosomes from biofluids is a prerequisite to both immunotherapy and diagnosis; however, modern isolation techniques are extremely ineffective. Specific peptide libraries known as aptamers have enabled significant progress in exosomal isolation, but they have not been effectively utilized. This work focused on developing a comprehensive approach to diagnosis involving peptide immunosignatures and tumor exosome separation using a modified Deterministic Lateral Displacement (DLD) array. We hypothesized that constructing a DLD array fitted with protein-specific aptamers would increase aptamer binding affinity, because the DLD enlarges the available contact area for exosome surfaces by limiting external particle collisions. The Lattice-Boltzmann fluidic simulation was used to compare current separation techniques to the modified DLD array; the results demonstrated that the modified DLD array most significantly improved aptamer binding affinity. Our project proved that a combinative approach utilizing immunosignature data to formulate a specialized DLD array presents a novel, cost-effective, and minimally invasive approach to pre-symptomatic diagnosis, and enables future research regarding patient-specific targeted treatment.

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