Size- and deformability-based isolation of circulating tumor cells using a microcavity array

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Circulating tumor cells (CTCs) are defined as tumor cells circulating in the peripheral blood of patients with metastatic cancer and the detection of them has clinical significance in cancer therapy. In conventional techniques, CTCs are enriched from whole blood using magnetic beads coated with epithelial cell adhesion molecule (EpCAM). However, this immunomagnetic separation method requires multiple handling steps and CTC recovery efficiency is relatively low.

In this report, we developed a size selective microcavity array for rapid and efficient detection of CTCs from whole blood. The array has a high-density microcavity array with 10,000 microcavities and enabled specific enrichment of tumor cells from whole blood according to the size and deformability differences between tumor cells and hematologic cells. The array was integrated with a microfluidic device to implement the enrichment, staining, and washing processes in a microfluidic assay within one integrated device. Using this device, tumor cell lines spiked within 1 mL of whole blood are selectively enriched with high efficiency at over 80% within 15 minutes and then easily enumerated by scanning of specified area using an automated fluorescence microscope. Furthermore, approximately 98% of recovered tumor cell lines were viable and proliferated after recovery from whole blood. In addition, EpCAM-negative tumor cells that cannot be isolated by conventional immunomagnetic separation were successfully recovered. Thus, our device has potential as efficient tool for rapid and efficient detection and subsequent molecular analysis of CTCs. This technology would be used for early diagnoses and future therapy guidance of metastatic cancers.