Toward precision oncology: SERS microfluidic platforms for multiplex biomarker analysis in liquid biopsy

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Cancer, being a dynamic disease characterized by heterogeneous molecular features, undergoes continual evolution throughout its progression.[1] The current diagnostic and monitoring methodologies rely on invasive tissue biopsies, which fail to adequately address this heterogeneity. In contrast, liquid biopsy-based approaches in precision oncology offer notable advantages such as, minimally invasive procedures allowing for frequent sampling, cost-effective tests, patient stratification based on dynamic assessment of tumor heterogeneity and real-time monitoring of treatment responses.[2]

To realize precision oncology with liquid biopsy and effectively tackle cancer heterogeneity during treatment, analyzing single Circulating Tumor Cells (CTCs) and their biomarker protein expression levels could prove to be a potent strategy for establishing precise signatures for individual patients.[3] Among the various methodologies developed for tumor biomarker analysis, microfluidic devices integrated with Surface Enhanced Raman Scattering (SERS) are emerging as powerful techniques due to their potential for multiplexing and high sensitivity.[4] Notably, microfluidic devices offer miniaturized platforms for ultrasensitive molecular analysis, while SERS provides extremely narrow spectra for intrinsic multiplexing.[5]

Herein, we present various SERS microfluidic platforms designed for single CTC analysis and characterization of their biomarker protein expression across different cancer types. These platforms selectively capture single CTCs from peripheral blood mononuclear cells of cancer patients. Through studies involving cell line models and patient samples, we demonstrated that the assay can selectively capture single CTCs and concurrently detect multiple protein biomarkers on their surface. Furthermore, the platform can stratify CTCs into different subpopulations based on changes in their cancer-associated protein signatures in response to drug treatment. This facilitates the identification of CTC subpopulations potentially resistant to treatment, aiding clinicians to find potential combination treatment targeting therapy-resistant cancer cells.

This presentation will review these advancements, emphasizing the applicability of SERS-Microfluidic Platforms for single CTC analysis in precision oncology. We anticipate that these platforms will hold significant clinical importance in disease diagnosis and treatment monitoring, further enhancing our understanding of cancer heterogeneity.

References:

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