Impedance cytometry as a tool for prognostic analysis in prostate cancer treated with radiotherapy

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Introduction:

Metastatic prostate cancer (PCa) is challenging to treat due to a limited understanding of the mechanisms driving metastasis development and the absence of reliable prognostic markers [1]. Liquid biopsy analysis is a clinically approved minimal blood test based on the enumeration of circulating tumor cells (CTC) and used to assess early patient prognosis and response to the treatment, including radiotherapy [2]. Due to the high CTC heterogeneity and plasticity, the currently approved tests need further improvement in terms of accuracy and reliability [3]. Recent studies suggest that the electro-physical properties of cancer cells, such as conductivity (σ) and permittivity (ε), may be utilized as potential prognostic markers [4-6]. Despite the high clinical demand, a method for distinguishing primary tumor and metastatic PCa cells based on their electrical properties has yet to be reported.
In this study, we will employ nano- and microfabrication techniques to develop an impedance cytometry approach in conjunction with various biological models to train our system. Thanks to the collaboration between biological and engineering research groups, we will have the opportunity to test advanced biological models, including cell culture (*in vitro*), synergetic mouse models, and patient samples. The increased complexity of these models has the potential to significantly improve the training process of machine learning data analysis.

Materials and methods:

To create the electronic sensing structures, we are utilizing both electron beam lithography (EBL) and ultraviolet (UV) lithography. The interdigitated sensing structures are formed through metal deposition. Additionally, we employ soft lithography to imprint cytometrical microchannels into polydimethylsiloxane (PDMS).

Results:

We are currently developing a detection system that will be used to assess the electro-physical properties of primary tumors, metastases, and CTCs.

Outlook:

In the future, this impedance cytometry system may be used to develop reliable prognostic tests based on the detection and enumeration of CTCs with metastatic properties in patients' samples. Additionally, analyzing circulating immune cell populations during radiotherapy may help characterize the immune status of patients and predict tumor immune evasion.

Conclusions:

The development of a label-free, sensitive, and reliable non-invasive diagnostic test based on the electric properties of tumor cells is expected to improve the sensitivity and reproducibility of traditional liquid biopsy-based diagnostic approaches and make them more time and labor-efficient.

References

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Figures

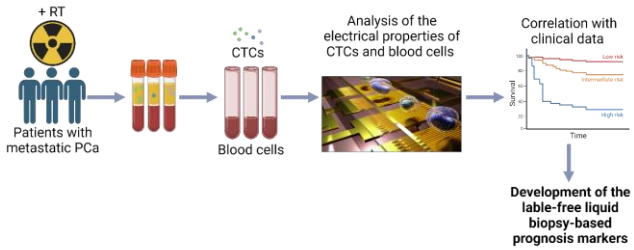

Figure 1. For prostate cancer (PCa) patients undergoing radiotherapy (RT), we are developing a non-invasive prognostic method that combines Liquid Biopsy and electrical impedance cytometry. This approach involves enumerating circulating tumor cells (CTCs) from blood samples and scrutinizing their electrical properties using an impedance cytometer. Our journey toward establishing a dependable platform for prognostic marker analysis encompasses preclinical development, from *in vitro* to *in vivo* experiments to examining patient-derived samples.