Fourier-transform infrared spectroscopy

Fourier-transform infrared spectroscopy (FTIR) is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid or gas. An FTIR spectrometer simultaneously collects high-resolution spectral data over a wide spectral range.

Cameron et al. applied the Dxcover® Cancer Liquid Biopsy to examine eight different cancers. The test uses Fourier-transform infrared spectroscopy (FTIR) and machine learning algorithm to detect cancer.

Area under the receiver operating characteristic curve (ROC) values were calculated for eight cancer types versus symptomatic non-cancer controls: brain (0.90), breast (0.76), colorectal (0.91), kidney (0.91), lung (0.91), ovarian (0.86), pancreatic (0.84) and prostate (0.86). We assessed the test performance when all eight cancer types were pooled to classify 'any cancer' against non-cancer patients. The cancer versus asymptomatic non-cancer classification detected 64% of Stage I cancers when specificity was 99% (overall sensitivity 57%). When tuned for higher sensitivity, this model identified 99% of Stage I cancers (with a specificity of 59%).

This spectroscopic blood test can effectively detect early-stage disease and can be fine-tuned to maximize either sensitivity or specificity depending on the requirements of different healthcare systems and cancer diagnostic pathways. This low-cost strategy could facilitate the requisite earlier diagnosis when cancer treatment can be more effective, or less toxic.

The earlier diagnosis of cancer is of paramount importance to improve patient survival. Current liquid biopsies are mainly focused on single tumor-derived biomarkers, which limits test sensitivity, especially for early-stage cancers that do not shed enough genetic material. This pan-omic liquid biopsy analyses the full complement of tumor and immune-derived markers present within blood derivatives and could facilitate the earlier detection of multiple cancer types. There is a low barrier to integrating this blood test into existing diagnostic pathways since the technology is rapid, and simple to use, only minute sample volumes are required, and sample preparation is minimal. In addition, the spectroscopic liquid biopsy described in this study has the potential to be combined with other orthogonal tests, such as cell-free DNA, which could provide an efficient route to diagnosis. Cancer treatment can be more effective when given earlier, and this low-cost strategy has the potential to improve patient prognosis [1)].

Dučić et al. exploited synchrotron radiation-based soft X-ray tomography and hard X-ray fluorescence for elemental microimaging of the shock-frozen Glioblastoma cells. The present study focuses instead on the biochemical profiling of live Glioblastoma cells and provides new insight into tumor heterogenicity. They studied bio-macromolecular changes by exploring the live-cell synchrotron-based Fourier-transform infrared spectroscopy (SR-FTIR) microspectroscopy in a set of three Glioblastoma cell lines, including the patient-derived glioblastoma cell line, before and after riluzole treatment, a medicament with potential anticancer properties. SR-FTIR microspectroscopy shows that Glioblastoma live cells of different origins recruit different organic compounds. The riluzole treatment of all Glioblastoma cell lines mainly affected carbohydrate metabolism and the DNA structure. Lipid structures and protein secondary conformation are affected as well by the riluzole treatment: cellular proteins assumed cross β-sheet conformation while parallel β-sheet conformation was less

represented for all Glioblastoma cells. Moreover, they hoped that a new live-cell approach for Glioblastoma simultaneous treatment and examination can be devised to target cancer cells more specifically, i.e., future therapies can develop more specific treatments according to the specific bio-macromolecular signature of each tumor type [2].

1)
Cameron JM, Sala A, Antoniou G, Brennan PM, Butler HJ, Conn JJA, Connal S, Curran T, Hegarty MG, McHardy RG, Orringer D, Palmer DS, Smith BR, Baker MJ. A spectroscopic liquid biopsy for the earlier detection of multiple cancer types. Br J Cancer. 2023 Sep 16. doi: 10.1038/s41416-023-02423-7. Epub ahead of print. PMID: 37717120.
2)
Dučić T, Ninkovic M, Martínez-Rovira I, Sperling S, Rohde V, Dimitrijević D, Jover Mañas GV, Vaccari L, Birarda G, Yousef I. Live-Cell Synchrotron-Based FTIR Evaluation of Metabolic Compounds in Brain Glioblastoma Cell Lines after Riluzole Treatment. Anal Chem. 2021 Dec 29. doi: 10.1021/acs.analchem.1c02076. Epub ahead of print. PMID: 34965097.