Tumour removal with a cancer cell clear margin

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Credit: Benjamin Franklin Pierce

A biopsy reporting that cancer cells are still in the margin indicates a likelihood of cancer cells remaining in the body. An EU-funded project, IMAGINE, has developed a unique tissue 'optical biopsy' technology to assess tumour margins.

Positive cancerous margins after surgery lead to an increased risk of progression and reduced disease-free survival. However, obtaining clear margins of cancerous lesions can be very challenging during surgery.

Early identification and adequate surgical intervention are critical measures for reducing the cancer-related mortality rates and cost burden on society. The inability to visualise the margin infiltration of cancers represents a significant challenge in many areas of oncology. Currently,

the border is examined in the excised tumour. The first step is performed during the operation and the second after the procedure. This approach is labour intensive with an inherent risk of leaving cancerous tissue in situ or even spreading the disease.

Radical new imaging technology in cancer surgery

The IMAGINE (Widefield Raman imaging probe for intraoperative margin assessment of cancers) project developed a platform technology that can be used for intraoperative cancer margin assessment. "By designing the first widefield Raman prototype for surgery and its assembly, we can now image phantoms (tissue constructs mimicking the optical properties of tissues) and human cells/tissues," outlines the Marie Skłodowska-Curie Action (MSCA) fellow heading up the research, Dr. Mads Bergholt.

Raman spectroscopy is a unique label-free optical technique based on inelastic light scattering that offers tissue 'optical biopsy' at molecular level. This new type of imaging could increase the targeting selectivity to accurately identify tumour cells. As such, "this could potentially improve surgery outcomes as well as reduce health care expenses and burden on the individual patient," explains Dr. Bergholt.

Spreading the word on tissue optical properties

Hosted by Prof. Molly Stevens' group at Imperial College London (ICL), the multinational culture and multidisciplinary environment witnessed successful analysis of pig and mouse cancer cells and tissues. "The (MSCA) Fellowship has directly given rise to concrete outputs in the form of publications and conference presentations including *Nature Communications*, *Science Advances*, *ACS Central Science* and *Nature Partner Journals Regenerative Medicine*," says Dr. Bergholt.

"We are also finalising a manuscript on my research of tissue optical properties and Monte Carlo modelling of photon transportation in tissue," he continues. Based on the results obtained from the Stevens Group, Bergholt has delivered several seminars in different universities including University of Southern Denmark, Sheffield University and King's College London. "Additionally, I presented my research at the largest biophotonics conference (SPIE Photonic West 2017) attracting more than 10 000 scientists," Bergholt concludes.

Challenges met and success delivered

To complete the initial optical design of the Raman prototype required optimisation. IMAGINE ensured the clinical viability by successfully adopting a new optical approach for imaging that offers more efficient laser illumination of tissue.

The MSCA achieved significant progress as the design of the Raman imaging platform gained new insight into photon propagation in tissue phantoms, mimicking optical properties of tissue and cancer cells. The Fellowship has therefore paved the way for further exploration of Raman-based methods for cancer detection and diagnosis.

Raman spectroscopy represents a novel biomolecular approach for targeting of cancers in vivo. Summing up the future impact of the IMAGINE research, Dr. Bergholt states, "We are aiming ultimately to translate this technology to the patient bedside."

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