Brain metastases occur in 20-40% of all cancer patients and impact quality of life and survival. Stereotactic radiosurgery (SRS) which involves delivering high doses of radiation to the tumour is the preferred treatment for these patients. It is also associated with a survival advantage as compared to whole brain radiation. The main difficulties with SRS are determining whether the tumour is responding early after the treatment, and managing radiation-induced late effects. Evaluating response of brain metastases to SRS early after the treatment allows the oncologists to adjust the treatment early and may improve outcomes. If a non-responder is identified early, repeat SRS or surgery can be performed. For responders, long-term monitoring is also needed for differentiating potential tumour progression from late radiation necrosis, what is challenging too. Both conditions present with similar characteristics while requiring different treatments. Salvage therapy is needed for tumour progression while necrosis is managed with steroids.

Our main focus is to develop and evaluate new magnetic resonance imaging (MRI) methods to investigate and quantify the metabolic and micro-structural changes that the tumour cells undergo after SRS. Preliminary results of our studies with the use of developed quantitative MRI techniques have been promising: we have shown that, new MRI methods allow for robust evaluation of treatment induced changes in tumour micro-environment. They can also identify regions with high metabolic activity, and are capable of detecting early cell death following treatment. In a preliminary study we applied these techniques in ~20 patients with brain metastasis undergoing stereotactic radiosurgery. We were able to separate responders from non-responders as early as one-week after treatment, predict how much the tumour would shrink one-month post-treatment, and identify the patients that do not benefit from SRS even before treatment.

In this study a total of 100 patients over 3 years will be recruited. Patients will be monitored continuously after treatment with a combination of clinical and quantitative MRI. We hypothesize that quantitative MRI biomarkers, that probe the cellular, vascular, and metabolic characteristics of the tumour, could provide accurate assessment of cancer treatment. These techniques will allow clinicians to identify responding patients within one-week post-treatment, and differentiate radiation necrosis from tumour progression. In consequence, treatment for brain metastases may be faster, more effective and less stressful for the patients. Moreover, this study provides researchers with improved tools to evaluate new experimental cancer treatments.