Project Discovery - Using molecular imaging for precision medicine approaches to SCI (spinal cord injury)

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Despite extensive research and clinical advances in spinal cord injury (SCI) research, currently, prognosis of spinal cord injury (SCI) is based upon an invasive standardised physical examination and magnetic resonance imaging (MRI). However, to accurately assess the benefits of future novel therapies, we must develop more robust diagnostic and prognostic tools which allow accurate, non-invasive measurements of injury severity and functional impairment.

Our advanced imaging project aimed to develop the world's first Positron Emission Tomography (PET) study SCI protocol for the assessment of biological markers (biomarkers) and to determine if altered expression of [^{18}F]GE-180 correlates with injury severity and functional impairment following SCI.

By developing a novel PET protocol for specifically for the assessment and analysis of inflammatory biomarkers, we detected significant differences in [^{18}F]GE-180 expression in the injured spinal cord which was strongly correlated with neurological severity and impairment following SCI.

1. Research purpose

The symptoms of spinal cord injury (SCI) can vary widely depending on the location and severity of damage along the spinal cord, which can lead to a range of prognoses from full recovery (rare cases) to permanent paralysis. Although clinicians use standardised physical examinations and magnetic resonance imaging to diagnose SCI and provide prognoses to patients, these methods may not accurately predict long-term outcomes. This makes it difficult to develop an effective management plan for improving the patient's quality of life. To address this issue, we proposed the use of positron emission tomography-computed tomography (PET-CT) to measure biological markers (biomarkers) of recovery and predict participant outcomes. Our study focused on using PET-CT analysis of [18F]GE-180 to measure biomarkers of inflammation at various timepoints following SCI. In a world-first clinical trial, we aimed to determine if [^{18}F]GE-180 expression correlates with neurological severity and impairment.

2. Methodology

South Australian participants with an SCI were recruited from the RAH Spinal Unit, Hampstead Rehabilitation Centre, the Repat Health Precinct and General Adelaide Regions. PET-CT imaging was performed at the Clinical Research Imaging Centre (CRIC, SAHMRI) and the RAH Nuclear Medicine Department. Participants were injected with a small amount (~185 MBq) of radioactive tracer [^{18}F]GE-180 into their bloodstream which bound to inflammatory cells, allowing us to take images using a specialised gamma camera. This allowed us to detect the radiation being emitted from the body and measure the distribution of inflammation in the injured spinal cord. [^{18}F]GE-180 was produced by the TGA approved Molecular Imaging and Therapy Research Unit (MITRU, SAHMRI).

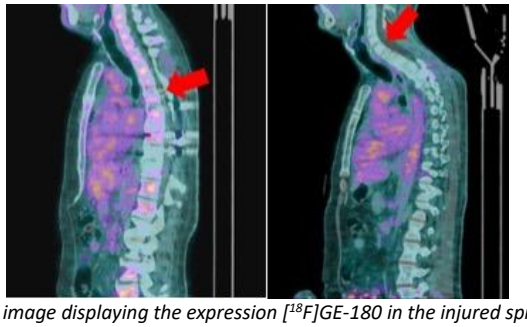

Figure 1. Co-registered PET-CT (static) image displaying the expression [^{18}F]GE-180 in the injured spinal cord of participants with various degrees of neurological severity and function.

3. Findings

In a world first clinical trial, we developed a PET-CT protocol and analysis pipeline to assess biomarkers of neurological recovery after SCI. We detected and measured [^{18}F]GE-180, a biomarker of inflammation, in all participants and found significant differences in expression, particularly in those with the most severe neurological impairment, including complete loss of sensory or motor function. We observed significant correlation between [^{18}F]GE-180 expression and neurological severity/impairment. Notably, participants who reported improvements in neurological functional assessments, had lower [^{18}F]GE-180 expression compared to those who did not

Our clinically viable tool can aid researchers, clinicians and specialists in utilising PET-CT to transform the diagnosis and prognosis of SCI and measure the assessment of novel and existing therapeutic interventions. The development and validation of this tool can bring significant improvements to the management and treatment of SCI.