Spinal cord injuries (SCI) affect 2.5 to 4 million people worldwide (40,000 in France). SCI induce sensory and motor symptoms leading to complete tetraplegia for the most severe lesions. Magnetic resonance imaging (MRI) is the only method used to follow patients with a spinal cord injury.

In this study, we have developed an in vivo MRI follow-up that accurately assess the progression of a lesion of the spinal cord in mice and non-human primates. The objective being to use the same techniques in humans and animals.

In particular, we showed that the CX3CR1+/eGFP and Aldh1l1-EGFP mice, that respectively express a fluorescent protein (eGFP) in microglia and astrocytes exhibit different functional recovery, and a better one is observed in CX3CR1+/eGFP mice. In order to identify whether these recoveries are associated with a differential evolution of the lesion, we performed a longitudinal follow-up using T2-weighted in vivo MRI. We also performed additional analyzes of spinal cord tissues using two ex vivo MRI (T2 and diffusion weighted MRI) as well as detailed histological analysis. Finally, we implemented our analysis with a longitudinal in vivo diffusion-weighted MRI follow-up of lesion evolution on an additional group of mice. Ex and in vivo diffusion-weighted MRI allowed identifying a lower lesion area at the epicenter in CX3CR1+/eGFP mice, the strain that recovers better.

We then evaluated the impact of a therapeutic strategy based on the modulation of the glial scar that plays a major role on the absence of spontaneous axonal regrowth after spinal cord injury. This modulation consists in a transient pharmacological depletion of microglia proliferation and its evaluation was carried out by an imaging and histological follow-up of treated and untreated animals. MRI monitoring did not permit to identify a difference in lesion extension and volume between groups. However, we observed a difference in parallel apparent diffusion coefficient (ADC//, diffusion gradient applied in axons direction) detected between the two groups, attesting of an effect of the treatment on the cellular organization after an SCI.

Finally, we used in and ex vivo MRI to characterize a new model of spinal cord injury in a non-human primate. We demonstrated that a lateral hemisection of the spinal cord in Microcebus murinus is a reproducible non-human primate model of SCI that could be further used to promote translational research.

We therefore characterized the use of in and ex vivo MRI to compare two mouse strains with different recovery after SCI. Similarly, the in and ex vivo follow-up of another species, Microcebus murinus, a nonhuman primate, allowed the characterization of a new SCI model. Finally, using MRI we detected a difference in parallel diffusion coefficient that was induced by the specific and transient depletion of microglia in a SCI context.