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In vivo spatiotemporal dynamics of NG2 glia activity caused by neural electrode implantation

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Neural interface technology provides direct sampling and analysis of electrical and chemical events in the brain in order to better understand neuronal function and treat neurodegenerative disease. However, intracortical electrodes experience inflammatory reactions that reduce long-term stability and functionality and are understood to be facilitated by activated microglia and astrocytes. Emerging studies have identified another cell type that participates in the formation of a high-impedance glial scar following brain injury; the oligodendrocyte precursor cell (OPC). These cells maintain functional synapses with neurons and are a crucial source of neurotrophic support. Following injury, OPCs migrate toward areas of tissue injury over the course of days, similar to activated microglia. The delayed time course implicates these OPCs as key components in the formation of the outer layers of the glial scar around the implant. *In vivo* two-photon laser scanning microscopy (TPLSM) was employed to observe fluorescently-labeled OPC and microglia reactivity up to 72 hours following probe insertion. OPCs initiated extension of cellular processes (2.5 ± 0.4 μm h^{-1}) and cell body migration (1.6 ± 0.3 μm $hour^{-1}$) toward the probe beginning 12 hours after insertion. By 72 hours, OPCs became activated at a radius of about 190.3 μm away from the probe surface. This study characterized the early spatiotemporal dynamics of OPCs involved in the inflammatory response induced by microelectrode insertion. OPCs are key mediators of tissue health and are understood to have multiple fate potentials. Detailed spatiotemporal characterization of glial behavior under pathological conditions may allow identification of alternative intervention targets for mitigating the formation of a glial scar and subsequent neurodegeneration that debilitates chronic neural interfaces.

Keywords: Glial progenitor, microelectrode array, insertion, neuroinflammation, gliosis, glial activation, ramification