Bio Focus

Nanowires promise reduced inflammation at the neural interface

Neural interfaces—devices designed to communicate with the nervous system—have the potential to deliver great advances in medical care and brain research. However, this has been hampered by declines in the performance of these structures over time, due to inflammation that separates healthy neural tissue from the interface. This occurs even when biocompatible materials are used to create the interfaces. Researchers suspect that mechanical damage by the relatively large and stiff electrodes is causing the inflammation.

"A promising approach to further increase the mechanical compliance of a flexible implant and thus mitigate the inflammatory response is to use compliant nanomaterials, such as nanowires, to cover the surface of the neural interfaces," says researcher Cecilia Eriksson Linsmeier of Lund University, Sweden. "However, before implementing such nanostructured electrode designs *in vivo*, there was a pressing need for a safety study."

As reported in the February issue of *Biomaterials* (DOI:10.1016/j.biomaterials.2014.11.051), Linsmeier, L. Gällentoft, L. Pettersson, and colleagues from the Neuronano Research Center at Lund University injected hafnium-oxide coated, gallium phosphide nanowires into the brains of rats. After either 12 weeks or one year, the inflammation response was investigated using immunostaining and confocal fluorescence microscopy. With the exception of the rats injected with the longest nanowires (10 μm), minimal inflammation was observed, and the response did not increase after 12 weeks. The shortest nanowires (2 μm) were typically found engulfed in immune cells, while the longer nanowires (5 μm and 10 μm) were typically found to be free in the brain tissue.

"We found that short nanowires (2 μm) could be considered safe and interesting for use as a surface modification material on neural interfaces. It is probable that such a coating would improve the electrical properties and might even lower the evoked inflammatory tissue response toward an implanted neural interface," says Linsmeier.

"This finding is highly relevant to the design of neural prostheses," says Dominique Durand, professor of biomedical engineering at Case Western Reserve University and Editor-in-Chief of the *Journal of Neural Engineering*. "However, it is not clear if this effect can be attributed to the compliance of the material or rather to the ability of macrophages and microglial cells to ingest the small versus the long nanowires through phagocytosis. Also it would be important to know what the tissue reaction would be if the nanowires were attached rather than loose."

If the materials of the neural interface exhibit effective connections with the brain tissue while being kept smaller than the immune cells, it should be possible to develop interfaces that do not exhibit the same decline in performance that has previously been observed.

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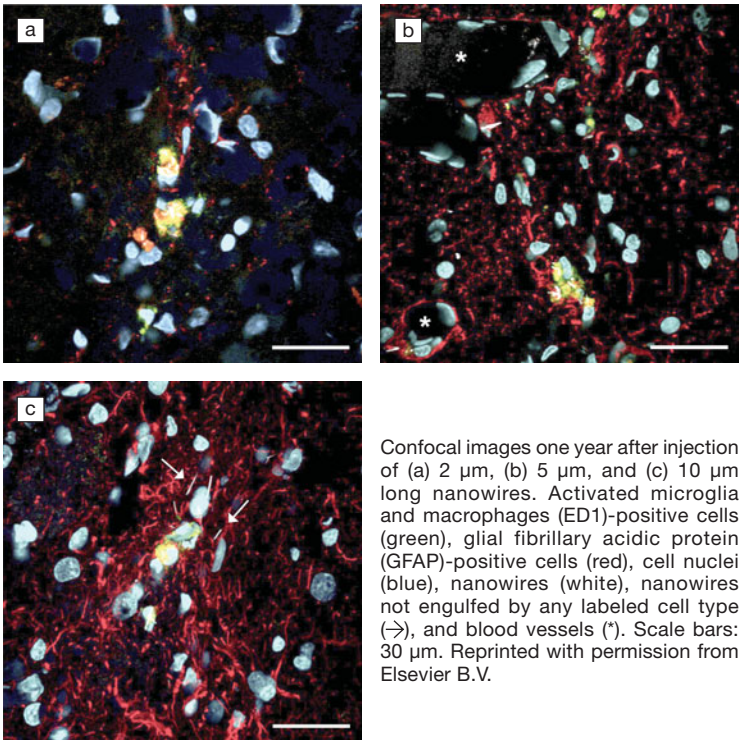

Confocal images one year after injection of (a) 2 μm, (b) 5 μm, and (c) 10 μm long nanowires. Activated microglia and macrophages (ED1)-positive cells (green), glial fibrillary acidic protein (GFAP)-positive cells (red), cell nuclei (blue), nanowires (white), nanowires not engulfed by any labeled cell type (→), and blood vessels (*). Scale bars: 30 μm. Reprinted with permission from Elsevier B.V.

Erratum

In *MRS Bulletin* **40** (4) 2015, in the original version of the article, "Cathodoluminescence microscopy: Optical imaging and spectroscopy with deep-subwavelength resolution," the photographs of two of the authors (Brenny and Vesseur) were mistakenly switched. The Materials Research Society and Cambridge University Press regret this error. The online version has been corrected to rectify this error (doi: 10.1557/mrs.2015.64).

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