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Nanowire biocompatibility in the brain: So far so good

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The biological safety of nanotechnology, in other words, how the body reacts to nanoparticles, is a hot topic. Researchers at Lund University in Sweden have managed for the first time to carry out successful experiments involving the injection of so-called 'nanowires.'

In the future it is expected that it will be possible to insert nanoscale electrodes to study learning and memory functions and to treat patients suffering from chronic pain, depression, and diseases such as Parkinson's. But it is not known what would happen if the nanoelectrodes would break away from their contact points.

Scientists at Lund University have investigated this 'worst case by injecting nanowires in rat brains. The nanowires resemble in size and shape the registration nodes of electrodes of the future. The results show that the brain 'clean-up cells' (microglia), take care of the wires. After twelve weeks only minor differences were observed between the brains of the test group and the control group. The findings are published in Nano Letters.

"The results indicate that this is a feasible avenue to pursue in the future. Now we have a better base on which to develop more advanced and more useful electrodes than those we have today," explains Christelle Prinz, a scientist in Solid State Physics at the Faculty of Engineering (LTH), who, together with Cecilia Eriksson Linsmeier at the Faculty of Medicine, is the lead author of the article 'Nanowire biocompatibility in the brain - Looking for a needle in a 3D stack.'

Electrodes are already used today to counteract symptoms of Parkinson's disease, for instance. Future nanotechnology may enable refined and enhanced treatment and pave the way for entirely new applications.

One advantage of nanoscale electrodes is that they can register and stimulate the tiniest components of the brain. To study the biological safety - the biocompatibility - of these electrodes, the scientists first produced nanowires that were then mixed into a fluid that was injected into the rat brains. An equal number of rats were given the solution without the nanowires. After 1, 6, and 12 weeks, respectively, the researchers looked at how the rat brains were reacting to the nanowires.

The research project is run by the university's interdisciplinary Neuronano Research Center (NRC), coordinated by Jens Schouenborg at the Faculty of Medicine and funded by a Linnaeus grant and the Wallenberg Foundation, among others. The work has involved scientists from the Faculty of Medicine and from the Nanometer Consortium, directed by Lars Samuelson, LTH.

"We studied two of the brain tissue's support cells: on the one hand, microglia cells, whose job is to 'tidy up' junk and infectious compounds in the brain and, on the other hand, astrocytes, who contribute to the brain's healing process. The microglia 'ate' most of the nanowires. In weeks 6 and 12 we could see remains of them in the microglia cells," says Nils Danielsen, a researcher with the NRC.

The number of nerve cells remained constant for test and control groups, which is a positive sign. The greatest difference between the test and control groups was that the former had a greater astrocyte reaction at one week, but this level eventually declined. At weeks 6 and 12 the scientists were not able to detect any difference at all.

"Together with other findings and given that the number of microglial cells decreased over time, the results indicate that the brain was not damaged or chronically injured by the nanowires," Christelle Prinz concludes.

More information: pubs.acs.org/doi/abs/10.1021/nl902413x

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