Extra-short nanowires best for brain

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If in the future electrodes are inserted into the human brain - either for research purposes or to treat diseases - it may be appropriate to give them a 'coat' of nanowires that could make them less irritating for the brain tissue. However, the nanowires must not exceed a certain length, according to new research from Neuronano Research Center at Lund University in Sweden.

This is the conclusion from an experiment in which the long-term effects of nanowires of different sizes were tested. The nanowires were mixed into a saline solution that was injected into the brains of lab animals, and the results were compared with an injection of saline alone.

The nanowires that were only 2 micrometres long did not have any greater effect on the brain tissue than the pure saline solution, whereas nanowires of 5 and 10 micrometres caused inflammation in the surrounding brain tissue. After a year, there were also fewer nerve cells remaining in the vicinity of the longest nanowires, which suggests that over time they had had a neurotoxic effect.

"We also saw clumps of dead cells containing nanowires, especially with the longer wires. These are probably immune system cells that have tried to neutralize the foreign body. The cells in the immune system's 'cleaning patrols' are often up to 10 micrometres in diameter. They are therefore not able to enclose the long nanowires and die in the process", said Cecilia Eriksson Linsmeier.

Dr Eriksson Linsmeier is a researcher at the Neuronano Research

Center, an interdisciplinary centre at Lund University where researchers in medicine, engineering and science collaborate to develop electrodes that can be inserted into the brain. This technology can already help patients with Parkinson's disease and epilepsy. However, current electrodes are quite large and stiff, which over time causes scar tissue to form in the brain, in turn reducing the electrodes' capacity to influence the nerve cells.The researchers at the Neuronano Research Center therefore want to develop electrodes that are both smaller and more flexible. They also

want to furnish the electrodes with a coating of nanowires, which could produce both a more tissue-friendly surface and better registration of signals from the nerve cells. However, it is important that the nanowires do not damage the tissue if they were to break off from the electrode.

"We have studied a worst case scenario, in which the nanowires break off from the electrode and spread through the brain tissue. In order to proceed with research on brain implants, we must be able to prevent all possible side-effects", said Cecilia Eriksson Linsmeier.

For the same reason, the study was allowed to continue for an unusual length of time. The effect of the nanowires on the animals was studied both twelve weeks and one year after the injection of the nanowires into the brain. In this context, a year is an extremely long time frame - half the lifespan of a rat.

"A lot of changes take place in the brain as the animal ages. We also found that the long nanowires had certain effects that were not seen until after a year. The short nanowires, on the other hand, did not produce any obvious harmful effects either in the short or the long term", said Dr Eriksson Linsmeier.

She believes that the group's findings could be of significance both for future electrodes and in other contexts, such as the development of nanoparticles as drug carriers. This will most probably also require the particles to be small enough not to trigger an immune response.

More information: Size-dependent long-term tissue response to biostable nanowires in the brain, *Biomaterials*, www.sciencedirect.com/science/ … ii/S0142961214012289

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