Dangerous custodians: Immune cells as possible nerve-cell killers in Alzheimer's disease

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Progressive dementia of Alzheimer's patients is due to an inexorable loss of nerve cells from the brain. German neuroscientists have now shown that microglia may actually make a significant contribution to the loss of neurons associated with Alzheimer's disease.

Microglia are the cells responsible for immune surveillance in the brain, and they initiate protective inflammatory reactions in response to tissue damage and infection. An international team under the leadership of LMU neuroscientist Professor Jochen Herms has now shown that these cells may actually make a significant contribution to the loss of neurons associated with Alzheimer's disease.

About 1.2 million people are thought to suffer from this form of progressive dementia in Germany, and this figure is expected to double as the average age of the population continues to increase. Their new findings lead Professor Herms and his team to believe that, as the disease develops, stressed nerve cells secrete a chemical messenger that attracts microglia. The ensuing inflammatory reactions ultimately result in the elimination of the neurons. This implies that chemical signalling between nerve cells and microglia plays an important role in mediating neuron loss during the course of the disease. "We may be able to make use of these results to develop novel agents that can slow the rate of neuron loss by interrupting communications between the two cell types", says Herms. (Nature Neuroscience online, 21 March 2010)

It is estimated that as many as 18 million people currently suffer from Alzheimer's disease worldwide, and the numbers are rising. This form of progressive dementia is due to an inexorable loss of nerve cells from the brain that is associated with the formation of insoluble protein aggregates, called beta-amyloid plaques and tangles. Large numbers of microglia gather in the vicinity of these plaques. Microglia serve as immune "policemen" that use their long processes to monitor their surroundings for signs of tissue damage. In accordance with this role, it has been thought that they congregate near plaques in order to degrade them.

Using two-photon microscopy, Professor Herms and his colleagues at the LMU's Center for Neuropathology were able to look directly into the brains of genetically modified mice that develop many of the symptoms characteristic of Alzheimer's disease in humans. The mice had also been engineered to make fluorescent forms of proteins that are specific for neurons and microglia, and the imaging technique enabled the researchers to monitor the fate of identifiable neurons and microglia over periods of weeks and months.

This approach made it possible, for the first time, to visualize the loss of nerve cells in the brains of living mice. Nerve loss was found to be preceded by the activation of microglia. "We assume that the sick nerve cells near plaques secrete a chemical messenger that induces the microglia to home in on them", says Herms. "The best candidate for the messenger responsible is the chemokine fractalikine, which docks onto a receptor protein on the surface of the microglial cells." Indeed, when this receptor was genetically eliminated, nerve cell loss was prevented.

These results demonstrate that microglia are not only involved in the removal of the amyloid aggregates typical of Alzheimer's disease, they also contribute actively to the catastrophic loss of nerve cells. In this picture, the communication channel between nerve cell and microglia

that is mediated by the fractalkine receptor plays a crucial role in the pathology of Alzheimer's disease. "The new findings could possibly lead to new therapeutic approaches to preventing neuron loss", says Herms.

More information: "Microglial CX3CR1 knockout prevents neuron loss in an Alzheimer´s disease mouse model", Martin Fuhrmann, Tobias Bittner, Christian K.E. Jung, Steffen Burgold, Richard M. Page, Gerda Mitteregger, Christian Haass, Frank M. LaFerla, Hans Kretzschmar, and Jochen Herms, *Nature Neuroscience* online, 21 March 2010

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