
RSNA Press Release

Sodium Buildup in Brain Linked to Disability in Multiple Sclerosis

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OAK BROOK, Ill. — A buildup of sodium in the brain detected by magnetic resonance imaging (MRI) may be a biomarker for the degeneration of nerve cells that occurs in patients with multiple sclerosis (MS), according to a new study published online in the journal *Radiology*.

The study found that patients with early-stage MS showed sodium accumulation in specific brain regions, while patients with more advanced disease showed sodium accumulation throughout the whole brain. Sodium buildup in motor areas of the brain correlated directly to the degree of disability seen in the advanced-stage patients.

"A major challenge with multiple sclerosis is providing patients with a prognosis of disease progression," said Patrick Cozzone, Ph.D., director emeritus of the Center for Magnetic Resonance in Biology and Medicine, a joint unit of National Center for Scientific Research (CNRS) and Aix-Marseille University in Marseille, France. "It's very hard to predict the course of the disease."

In MS, the body's immune system attacks the protective sheath (called myelin) that covers nerve cells, or neurons, in the brain and spinal cord. The scarring affects the neurons' ability to conduct signals, causing neurological and physical disability. The type and severity of MS symptoms, as well as the progression of the disease, vary from one patient to another.

Dr. Cozzone, along with Wafaa Zaaoui, Ph.D., research officer at CNRS, Jean-Philippe Ranjeva, Ph.D., professor in neuroscience at Aix-Marseille University and a European team of interdisciplinary researchers used 3 Tesla (3T) sodium MRI to study relapsing-remitting multiple sclerosis (RRMS), the most common form of the disease in which clearly defined attacks of worsening neurologic function are followed by periods of recovery. Sodium MRI produces images and information on the sodium content of cells in the body.

At A Glance

- A buildup of sodium in the brain detected by MRI may be a biomarker for the degeneration of nerve cells that occurs in patients with relapsing-remitting MS.
- In relapsing-remitting MS patients, the amount of sodium accumulation in gray matter associated with the motor system was directly correlated to the degree of patient disability.
- In MS, the body's immune system attacks the protective sheath (called myelin) that covers nerve cells, or neurons, in the brain and spinal cord.

"We collaborated for two years with chemists and physicists to develop techniques to perform 3T sodium MRI on patients," Dr. Zaaraoui said. "To better understand this disease, we need to probe new molecules. The time has come for probing brain sodium concentrations."

Using specially developed hardware and software, the researchers conducted sodium MRI on 26 MS patients, including 14 with early-stage RRMS (less than five years in duration) and 12 with advanced disease (longer than five years), and 15 age- and sex-matched control participants.

In the early-stage RRMS patients, sodium MRI revealed abnormally high concentrations of sodium in specific brain regions, including the brainstem, cerebellum and temporal pole. In the advanced-stage RRMS patients, abnormally high sodium accumulation was widespread throughout the whole brain, including normal appearing brain tissue.

"In RRMS patients, the amount of sodium accumulation in gray matter associated with the motor system was directly correlated to the degree of patient disability," Dr. Zaaraoui said.

Current treatments for MS are only able to slow the progress of the disease. The use of sodium accumulation as a biomarker of neuron degeneration may assist pharmaceutical companies in developing and assessing potential treatments.

"Brain sodium MR imaging can help us to better understand the disease and to monitor the occurrence of neuronal injury in MS patients and possibly in patients with other brain disorders," Dr. Ranjeva said.



From left to right: Dr. Jean-Philippe Ranjeva, Ph.D., Dr. Wafaa Zaaraoui Ph.D., and Dr. Patrick Cozzone, Ph.D.

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"Distribution of Brain Sodium Accumulation Correlates with Disability in Multiple Sclerosis—A Cross-Sectional ^{23}Na MR Imaging Study." Collaborating with Drs. Cozzone, Zaaraoui and Ranjeva were Simon Konstandin, Ph.D., Bertrand Audoin, M.D., Ph.D., Armin M. Nagel, Ph.D., Audrey Rico, M.D., Irina Malikova, M.D., Elisabeth Soulier, Patrick Viout, Sylviane Confort-Gouny, Ph.D., Jean Pelletier, M.D., Ph.D., Lothar R. Schad, Ph.D.

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