White matter may aid recovery from spinal cord injuries: Study

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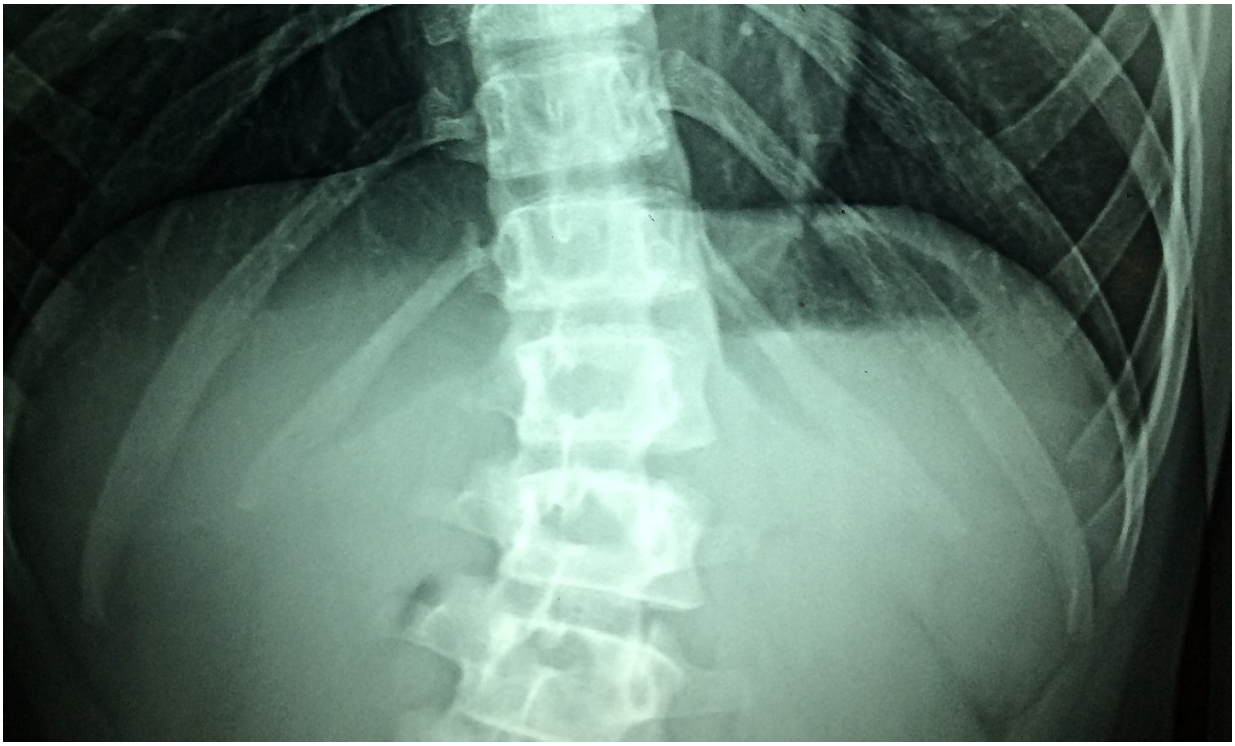

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Injuries, infection and inflammatory diseases that damage the spinal cord can lead to intractable pain and disability. Some degree of recovery may be possible. The question is, how best to stimulate the regrowth and healing of damaged nerves.

At the Vanderbilt University Institute of Imaging Science (VUIIS), scientists are focusing on a previously understudied part of the brain and spinal cord—white matter. Their discoveries could lead to treatments that restore nerve activity through the targeted delivery of electromagnetic stimuli or drugs.

As in the brain, the spinal cord is made up nerve cell bodies (gray matter), which process sensation and control voluntary movement, and axons (white matter), fibers that connect nerve cells and which project to the rest of the body.

In a recent paper published in the *Proceedings of the National Academy of Sciences*, Anirban Sengupta, Ph.D., John Gore, Ph.D., and their colleagues report the detection of signals from white matter in the spinal cord in response to a stimulus that are as robust as gray matter signals.

"In the spinal cord, the white matter signal is quite large and detectable, unlike in the brain, where it has less amplitude than the gray matter (signal)," said Sengupta, research instructor in Radiology and Radiological Sciences at Vanderbilt University Medical Center.

"This may be due to the larger volume of white matter in the spinal cord compared to the brain," he added. Alternatively, the signal could represent "an intrinsic demand" in metabolism within the white matter, reflecting its critical role in supporting gray matter.

For several years, Gore, who directs the VUIIS, and his colleagues have used functional magnetic resonance imaging (fMRI) to detect blood oxygenation-level dependent (BOLD) signals, a key marker of nervous system activity, in white matter.

Last year they reported that when people who are having their brains scanned by fMRI perform a task, like wiggling their fingers, BOLD

signals increase in white matter throughout the brain.

The current study monitored changes in BOLD signals in the white matter of the spinal cord at rest and in response to a vibrotactile stimulus applied to the fingers in an animal model. In response to stimulation, white matter activity was higher in "tracts" of ascending fibers that carry the signal from the spine to the brain.

This result is consistent with white matter's known neurobiological function, the researchers noted. White matter contains non-neuronal glial cells that do not produce electrical impulses, but which regulate blood flow and neurotransmitters, the signaling molecules that transmit signals between nerve cells.

Much remains to be learned about the function of white matter in the spinal cord. But the findings from this research may help in improved understanding of diseases that affect white matter in the spinal cord, including multiple sclerosis, Sengupta said.

"We will be able to see how activity in the white matter changes in different stages of the disease," he said. Researchers also may be able to monitor the effectiveness of therapeutic interventions, including neuromodulation, in promoting recovery following spinal cord injury.

Sengupta, the paper's corresponding author, earned his doctorate at the Indian Institute of Technology in New Delhi in 2018, and joined the Vanderbilt faculty in 2024 after completing a postdoctoral fellowship at VUIIS.

Gore is University Distinguished Professor of Radiology and Radiological Sciences, Biomedical Engineering, Molecular Physiology and Biophysics, and Physics and Astronomy. Other VUIIS co-authors were Arabinda Mishra, Feng Wang, Ph.D., and Li Min Chen, MD, Ph.D.

More information: Anirban Sengupta et al, Characteristic BOLD signals are detectable in white matter of the spinal cord at rest and after a stimulus, *Proceedings of the National Academy of Sciences* (2024). DOI: 10.1073/pnas.2316117121