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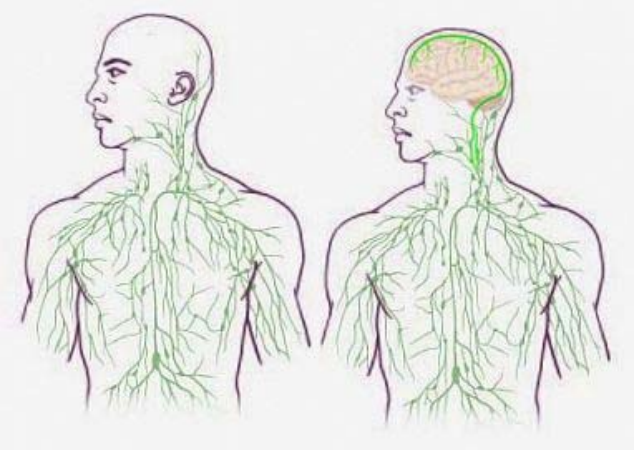
Lymphatic Vessels Discovered in Central Nervous System

At a Glance

- Scientists discovered that the brains of mice contain functional lymphatic vessels that can carry fluid and immune cells from cerebrospinal fluid.
- Further work will explore whether problems in this system might play a role in neurological disorders such as Alzheimer's disease, meningitis, and multiple sclerosis.

Fluids move throughout the body via several paths. The cardiovascular system circulates blood, nutrients, and gases throughout the body. The lymphatic system carries white blood cells and other immune cells through a network of vessels and tissues, including lymph nodes. The lymphatic system also serves as a connection between tissues and the bloodstream, performing several functions such as removing dead blood cells and other waste.



Maps of the lymphatic system: old (left) and updated to reflect the new discovery. *University of Virginia Health System.*

The brain, part of the central nervous system, has blood vessels but has been thought to lack lymphatic vessels, as theyve never been found. Researchers recently discovered a series of channels that surround blood vessels within the brains of mice. This system, managed by the brains glial cells, was termed the glymphatic system. It moves cerebrospinal fluid, a clear liquid surrounding the brain and spinal cord, quickly and deeply thoughout the brain, removing waste.

To better understand the connections between the lymphatic system and the brain, a team led by Drs. Antoine Louveau and Jonathan Kipnis of the University of Virginia School of Medicine used high-powered microscopes to examine the brains of mice. Their research was funded in part by NIH's National Institute on Aging (NIA) and National Institute of Neurological Disorders and Stroke (NINDS). Findings appeared online on June 1, 2015, in *Nature*.

The scientists examined layers of tissue, known as meninges, that cover the brain and contain blood vessels and cerebrospinal fluid. While searching for structures associated with the meninges, the researchers noticed vessel-like patterns. These vessels contained markers of the lymphatic system. By injecting dye into anesthetized mice and tracking its path, they found that the vessels carried fluid and immune cells from the cerebrospinal fluid, along veins in the

sinuses, and into nearby deep cervical lymph nodes. The researchers surmise that these vessels may serve as a second step in the drainage of fluid from the brain, after it's drained into the cerebrospinal fluid through the glymphatic system.

These vessels may have gone undiscovered until now due to their hidden location. The method the team used to prepare the meninges kept these layers intact. The researchers found similar structures in autopsy specimens of human meninges. Organization of the vessels in the human central nervous system will now need to be determined.

The discovery of a pathway for immune cells to exit the central nervous system raises the question of whether disruption of this route may be involved in neurological disorders that are associated with immune system dysfunction, such as multiple sclerosis, meningitis, and Alzheimer's disease.

"We think these vessels may play a role in pathogenesis of neurological conditions that have an immune component," Kipnis says.

—by Carol Torgan, Ph.D.

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- Immune System (http://www.niaid.nih.gov/topics/immunesystem/Pages/overview.aspx)

Reference:

Structural and functional features of central nervous system lymphatic vessels. Louveau A, Smirnov I, Keyes TJ, Eccles JD, Rouhani SJ, Peske JD, Derecki NC, Castle D, Mandell JW, Lee KS, Harris TH, Kipnis J. *Nature*. 2015 Jun 1. doi: 10.1038/nature14432. [Epub ahead of print]. PMID: 26030524.

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