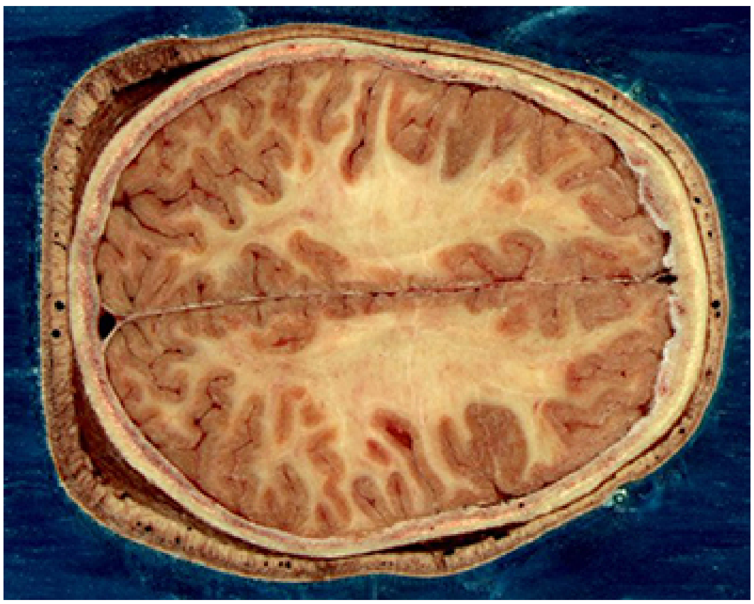
New understanding of stroke damage may aid recovery

March 6 2015, by Michael C. Purdy



A new study of how stroke damages the brain has shown that it is more likely to harm the white matter inside the brain, visible above in an image from the Visual Human Project at the National Library of Medicine. The insight may help scientists develop new strategies to help patients recover after stroke. Credit: National Library of Medicine

Stroke can lead to a wide range of problems such as depression and difficulty moving, speaking and paying attention. Scientists have thought these issues were caused by damage to the brain's "computer processors"—cells in the brain's outer layer that do much of the work involved in higher brain functions.

But a new study by researchers at Washington University School of Medicine in St. Louis has found compelling evidence that stroke damage to "cables" buried inside the brain plays an important role in these impairments. The cables connect cells on the brain's surface to each other, to other cells deep in the brain and to cells in the spinal cord that link the brain to the rest of the body.

"This study provides a new framework to think about the damage caused by stroke," said senior author Maurizio Corbetta, MD, the Norman J. Stupp Professor of Neurology. "A more complete and accurate description of the most common anatomical damage and deficits after a stroke will help us understand how the brain can adapt to recover lost functions and potentially lead to new rehabilitation strategies."

The results appear online March 4 in *Neuron*.

Neurologists' traditional approach to stroke originated with Paul Broca, a French surgeon who in 1861 linked a stroke patient's severe speech problems to damage to an area of the cortex, the outer layer of gray matter that wraps around the surface of the brain. The area Broca identified is underneath the left temple.

Since then, neurologists have continued in the tradition established by Broca and have associated different stroke-related problems to damage in particular areas of the cortex. That has led to the identification of a hodgepodge of dozens of different stroke-related syndromes that often are difficult to match precisely to an individual patient's symptoms.

With the advent of modern brain scans, scientists later discovered that stroke only rarely affects the cortex but often involves the tissue underneath the cortex, which is primarily composed of the fibers connecting different parts of the brain. In 2007, for example, a team used MRI to image the brain of Broca's first patient and found the stroke had caused significant damage to the white matter.

To get a better sense of how stroke damages the brain, Corbetta and his colleagues initiated a study of patients who had just suffered first-time strokes. The new study uses data gathered from 132 patients treated at Barnes-Jewish Hospital.

In every subject, the researchers used MRI scans of the brain to assess the extent and location of stroke damage. They also measured structural connectivity—the connections in the white matter; and functional connectivity—the ability of brain regions to communicate with each other in a coordinated fashion. They also examined attention, vision, movement, language and memory, which often are impaired by stroke. These evaluations occurred one to two weeks, three months and one year after each patient's stroke.

The results show that stroke is more likely to inflict the most harm in three areas of the brain, all under the cortex: the white matter; the basal ganglia, which are important in movement and reward; and the thalamus, which regulates sleep and consciousness, and plays roles in vision, hearing and touch.

The researchers also found that deficits after stroke are better described by three groupings rather than by many individual deficits. The first group was associated with problems with language and memory; the second was linked to problems with vision, left body movement, general attention and awareness of the left side of space; and the third was linked to problems with right body movement and awareness of the right side of space.

The combination of deficits across many patients was not due to the extent of damage caused by the strokes but to damage of white matter "crossroads," regions with fibers that have many connections. According to Corbetta, these lesions affect communication across many brain regions, which helps explain why the damage they produce causes such a diverse array of symptoms.

"The majority of research in stroke, including funding at the National Institute of Health, has focused on the cortex," Corbetta said. "Our results show the importance of loss of connections due to white matter damage, and highlight the need to look at the impact of stroke on the ability of undamaged brain regions to communicate. Future studies should focus on how the stroke affects brain function. This should be very helpful in diagnosis and treatment of these patients."

More information: Corbetta M, Ramsey L, Callejas A, Baldassarre A, Hacker CD, Siegel JS, Astafiev SV, Rengachary J, Zinn K, Lang CE, Connor LT, Fucetola R, Strube M, Carter AR, Shulman GL. "Common behavioral clusters and subcortical anatomy in stroke." *Neuron*, online March 4, 2015. DOI: dx.doi.org/10.1016/j.neuron.2015.02.027

Provided by Washington University in St. Louis