Understanding cerebral vasospasm brain injuries

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Dr. Javier Provencio is an associate professor in the University of Virginia's School of Medicine and director of UVA's Nerancy Neuroscience Intensive Care Unit. Credit: University of Virginia

Dr. Javier Provencio is on the trail of a 70-year-old medical mystery. He and colleagues at the University of Virginia School of Medicine have made strides in finding the culprit behind a type of delayed cognitive deterioration that plagues brain aneurysm survivors.

An associate professor of medicine and director of UVA's Nerancy Neuroscience Intensive Care Unit, Provencio focuses his research on a phenomenon known as cerebral vasospasm, also called delayed deterioration. This is a condition that affects nearly 30 percent of people who suffer and survive an aneurysm rupture.

A brain aneurysm occurs when there is a bulge in a blood vessel in the brain; it can leak or rupture and cause bleeding in the brain. It develops as a result of thinning artery walls.

The symptoms of a cerebral vasospasm typically strike patients four to seven days after the initial aneurysm rupture, starting a process of cognitive deterioration. Doctors first identified this condition in the 1950s and found it was linked to narrowed blood vessels in patients' brains, but the exact cause remains unclear.

In honor of Brain Injury Awareness Month, Provencio met with UVA Today to discuss the progress he and his team have made in understanding this condition and to explain the challenges we face in repairing damage to the body's most complex organ.

Q. What are the symptoms of a cerebral vasospasm? Is it fatal?

A. It's not typically fatal, but it seems to affect cognitive function and personality. It affects all executive functions, like memory and decision-making.

The cost of the disease is very high. The average age of a person with an aneurysm rupture is 45 and this delayed deterioration can keep them from working and diminish their ability to care for themselves. It basically turns people into zombies.

Q. What do you now believe to be the cause?

A. There have been many studies – some based here at UVA – that show that repairing the narrowed blood vessels does not necessarily improve the condition.

Because of that finding, we set out to look for other things that may account for the damage that aren't just blood vessels narrowing. That's how we happened on the idea of inflammation being the problem.

Typically, you think of innate or acute inflammation as part of the immune system's rapid response, not something that would begin four days after an incident. When that rapid response is happening, your body has cells called neutrophils that jump in at the first sign of infection or damage. These are the cells that spark inflammation.

Since cerebral vasospasm is delayed, we didn't expect this part of the early immune system response to be related. We were surprised to find that the level of neutrophils in the spinal fluid – part of the early response system – was elevated in people who had this delayed deterioration.

Early lab testing shows that if you take away the neutrophils at a specific time three days after the injury, the effects of the vasospasm and resulting deterioration don't occur. So now we have a culprit and we're trying to hone in on what that cell actually does and why.

Q. Outside of the aneurysm patients you treat, what

are the most common brain injuries you encounter?

A. The most common type in younger people is traumatic brain injuries; those are usually car accidents and other instances where people hit their heads. In the elderly population, even mild episodes of hitting your head can cause a type of brain bleed called a subdural hematoma. As we get older, the veins on the outside of our brain become brittle, and if you whack your head even a little bit, you can get bleeding around your brain from damage to those veins.

The other problem that we see frequently here is that patients with poorly controlled high blood pressure can get bleeding in their brain from vessels that rupture because their pressure has been so high for so long.

Q. How does brain damage from strokes differ from damage related to traumatic injuries?

A. Strokes are blood vessels that clot off, and because there's no single blood vessel that feeds the whole brain, stroke patients oftentimes have damage to just certain pieces of their brain, and those pieces of the brain that get damaged often have very specific effects on what they can do and what they can't do.

So if the left side of their brain is affected, then the right side of their body doesn't work because the nerves that control your movement system are crossed. With traumatic brain injuries, like those that happen in car accidents, the damage to the brain often affects the whole brain, so functions like your ability to reason and make sense and remember things are affected.

So patients with traumatic brain injury often have more global cognitive deficits, where patients with stroke often have more focused deficits.

Q. In other interviews, you've said that there are certain cognitive abilities that are harder to damage than others. Why is that and what are those abilities?

A. From an evolutionary standpoint, it's very hard to understand why you remember certain things differently, but there are some things that seem to be stored much more solidly in our brain.

For example, it's really hard to forget your name. No matter how damaged a person's brain is, if they can talk, most people can remember who they are. In fact, in cases where people can't remember their name, it's usually due to psychological trauma, not brain trauma.

We've come to the conclusion that this is because certain things that you practice over and over again, like your name, get stored in a different way. We're just starting to really understand why that is. We think there might be some evolutionary advantage to the idea that there is some information that you use so readily or that becomes such an important part of who you think you are that your brain doesn't store it in the same way that it stores say, where you left your pencil.

We're on the precipice of a change in our understanding of how everything works in the brain and how much the brain controls and how much we can modulate it. My feeling is that in the next 10 years or so, there are going to be some big discoveries.

Provided by University of Virginia