New metric for blood circulation in brain to better understand dementia

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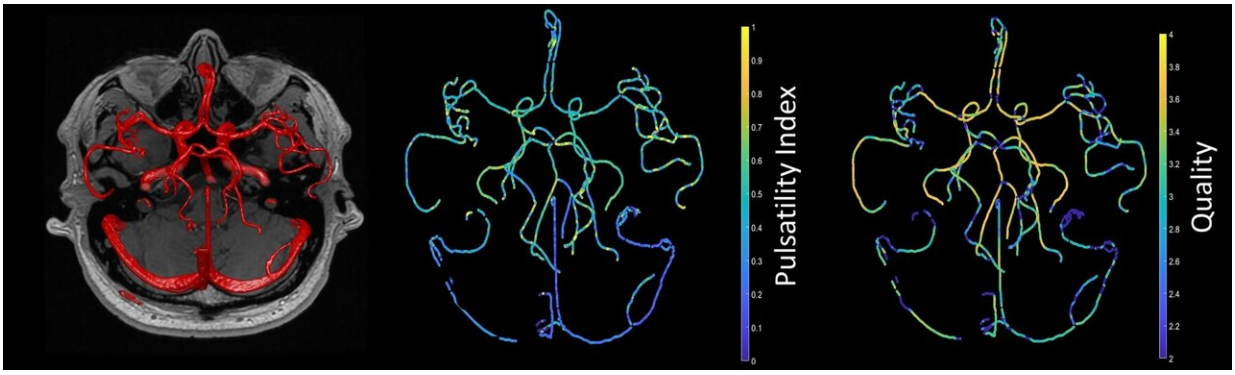

Example iso-surface of QVT segmentation from 4D flow (left) and visualization of ppi{p}_{pi} (center) and processing quality computed via Eq. 4 (right). Credit: *Scientific Reports* (2024). DOI: 10.1038/s41598-024-63312-4

Each time the heart beats, it pumps blood through the brain vessels, causing them to expand slightly and then relax, much like the rise and fall of the blood pulsing through your veins when you feel your pulse in your wrist. This pulsation in the brain helps distribute blood evenly across different areas of the brain, ensuring that all parts receive the oxygen and nutrients they need to function properly.

In healthy vessels, the pulse wave is dampened before it reaches the smallest vessels, where high pulsatility could be harmful. This new metric provides a comprehensive measure of the small vessel pulsatility

risk.

A paper just published in Scientific Reports by Sergio Dempsey as first author with colleagues Dr. Soroush Safaei, Dr. Gonzalo Maso Talou at Auckland Bioengineering Institute, along with co-author Dr. Samantha Holdsworth (Mātai and FMHS & CBR at the University of Auckland), describes the new metric based on 4D flow MRI technology.

This innovative metric is particularly crucial because increased vascular pulsatility is linked to several brain conditions, including Alzheimer's disease and other forms of dementia. By accurately measuring how pulsatility is transmitted in the brain, researchers can better understand the underlying mechanism of these diseases and potentially guide development of new treatments.

Current MRI methods face limitations due to anatomical variations and measurement constraints. The new technique removes this issue by integrating thousands of measurements across all brain vessels, rather than looking one spot at a time as the traditional methods. This provides a richer metric representative of the entire brain.

"The ability to measure how pulsatility is transmitted through the brain's arteries could revolutionize our approach to neurological diseases, and support research in vascular damage hypotheses," explained Mr. Dempsey. "Our method allows for a detailed assessment of the brain's vascular health, which is often compromised in neurodegenerative disorders."

The study also highlighted the potential to enhance clinical assessments and research on brain health. By integrating this new metric into routine diagnostic procedures, health care providers can offer more precise and personalized care plans for individuals at risk of or suffering from cognitive impairments.

In addition to its implications for patient care, the researchers have made their tools publicly available, integrating them into pre-existing open-source software. This enables scientists and clinicians worldwide to adopt the advanced methodology, fostering further research and collaboration in the field of neurology.

"Our findings are a promising step towards better understanding the vascular contributions to neurodegeneration," said Associate Professor Holdsworth, Mātai Director of Research. "We are excited about the metric's potential to become a standard part of neurological assessments and the positive impact it could have on millions of lives."

The research team is planning further studies to explore the applications of this technique in larger and more diverse populations, beginning with the "Digital Twin Dementia Study" starting at Mātai later this month.

Results from the initial study of the metric also identified important sex differences in vascular dynamics, which has initiated a new study focusing on sex-related dynamics which is anticipated to begin at Mātai and the Centre for Advanced MRI (CAMRI) in November.

More information: Sergio Dempsey et al, Measuring global cerebrovascular pulsatility transmission using 4D flow MRI, *Scientific Reports* (2024). DOI: 10.1038/s41598-024-63312-4

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