Abstract Submitted
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Hydraulic resistance of periarterial spaces in the brain[1] JOHN H. THOMAS, JEFFREY TITHOF, DOUGLAS H. KELLEY, HUMBERTO MESTRE, MAIKEN NEDERGAARD, University of Rochester — Periarterial spaces (PASs) are annular channels around arteries that carry a flow of cerebrospinal fluid (CSF) into the brain, bringing in nutrients and sweeping away metabolic waste. In vivo observations reveal that PASs are not concentric circular annuli, as often assumed, but instead are oblate and eccentric. We model the PAS cross-section as a circle (artery) surrounded by an ellipse (outer wall), and vary the area, oblateness of the ellipse, and eccentricity of the circle relative to the ellipse. This model can match observed shapes of PASs quite well. For each shape, we determine the velocity profile for steady, laminar flow and compute the corresponding hydraulic resistance. The minimum hydraulic resistance (maximum flow rate) for a given cross-sectional area occurs when the ellipse is elongated and intersects the circle, dividing the PAS into two lobes, as is common around pial arteries. If both boundaries are circular, the minimum hydraulic resistance occurs when the eccentricity is large, as is common around penetrating arteries. We show that the actual shapes of PASs are nearly optimal, offering the least hydraulic resistance for their size: this may well represent an evolutionary adaptation that maximizes the clearance of metabolic waste from the brain.

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