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Reduced-order modelling of microvascular arteriovenous malformations to identify lesion morphology with diagnostic imaging data

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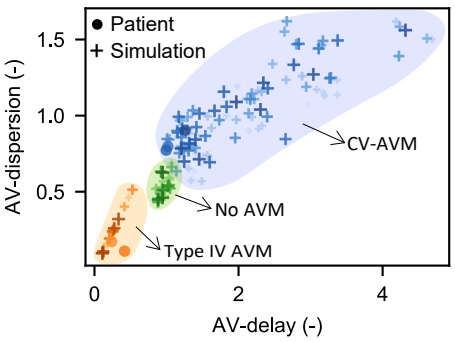
Arteriovenous malformations (AVMs) are congenital vascular anomalies, characterized by the presence of abnormal, low-resistance connections between arteries and veins[3]. When AVMs affect parts of the microcirculation, their angioarchitecture cannot be resolved in detail with contrast agent (CA)-based clinical imaging techniques. The only available information is their effect on macroscopic CA transport. With our computational model, we aim at identifying microvascular malformation morphologies based on macroscopic CA transport patterns.

This model consists of a small network of capillary vessels with a feeding arteriole and draining venule[2] and a set of prototype malformation morphologies. Flow rates and pressures are computed with a lumped parameter description of the network, while CA propagation is determined by solving the 1D advection-diffusion equation[1].

Among all considered pathological networks, we identified two lesion types, which correlate with the two most distinctive arteriovenous transport patterns in patients. One type is fast and non-dispersive and a second pattern exhibits slow and dispersive transport, when compared to the non-pathological vasculature. The presented model enables the identification of sub-resolution lesions with current clinical imaging modalities and can be extended to explore further unknown microvascular AVM morphologies.



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