Contribution ID: **402** Type: **Oral Presentation**

Reconstruction of Multiscale Structures of Cerebral Vasculature

Tuesday, 14 May 2024 14:30 (15 minutes)

The cerebral vasculature plays a vital role in nutrients delivery and metabolic waste removal in the brain, yet in which transport mechanisms are not fully understood. Numerical simulation is an effective approach for analyzing transport in the cerebral vasculature, depending on accurate acquisition of the cerebrovascular structure. However, the complex cerebrovascular structure poses a serious challenge for reconstruction of the entire vasculature.

Traditional methods for the reconstruction of cerebral vasculature include medical imaging and computational generation. Medical imaging relies on the scanning technology (such as DSA [1] and MRA [2]). Despite its effectiveness in clinical research, it's limited by their inability to capture small vessels in vivo due to resolution constraints. Alternatively, computational generation including simulated annealing algorithm [3], can overcome resolution limitations but often fall short in providing structures morphologically compatible with the real cerebrovascular structure.

In this study, we present a novel method for reconstructing the multiscale cerebral vascular system, which integrates anatomical findings with medical imaging. The proposed model merges macrovasculature derived from medical imaging which reflects real morphology, with microvasculature from random generation which could reach the resolution of capillary network. This integration allows a more accurate representation of the entire cerebral vasculature. Consequently, the flow simulations based on this model are in good agreement with medical experiments. This model provides an effective tool for simulating and understanding transport in the cerebral vasculature.

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References

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Session Classification: MS20

Track Classification: (MS20) Biophysics of living porous media: theory, experiment, modeling and characterization