Multiscale Modelling of 3-Dimensional Brain Tissue Using Ideal Capillary Model

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Abstract This project aims to investigate the effects of capillary size and shape toward the brain tissue poroelastic properties model using asymptotic expansion homogenization (AEH). Applying AEH to the existing poroelastic governing equations (GE) results in a new GE consists of 6 macroscale equations and 4 microscale cell problems. The cell problems are solved on a microstructure geometry of brain tissue with capillary embedded to obtain effective parametric tensors, namely the capillary and interstitial hydraulic conductivity (**K** and **G**), capillary and interstitial homogenous Biot's coefficient (α_c and α_t), Young's modulus (E) and Poisson's ratio (v). By varying the tortuosity, the percentage difference of **K** is 97.98%, shows that it is highly affected by tortuosity. The percentage difference of **G** is 0.25% implying that tortuosity insignificantly affecting **G**. Meanwhile, α_c and α_t decreases and increases with tortuosity, respectively. The percentage difference of E and v are 0.14% and 0.03% respectively, implying that both parameters does not affected by tortuosity. Besides, **K** is exponentially increases with the increase of radius. On the other hand, **G** decreases as the radius increases. Meanwhile α_c and α_t increases and decreases, respectively as radius increases. The percentage differences of E and v are 18.26% and 14.55% respectively, suggesting that they are significantly affected by the radius. In conclusion, capillary shape and size have significant impact on the simulation of human brain. Thus, both characteristics should be precisely emphasized in the development of the geometry so that accurate parameters can be obtained to solve macroscale equations in future.

Keywords Ischaemic stroke · Asymptotic expansion homogenization · Macroscale equations · Microscale cell problems · Ideal capillary model

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