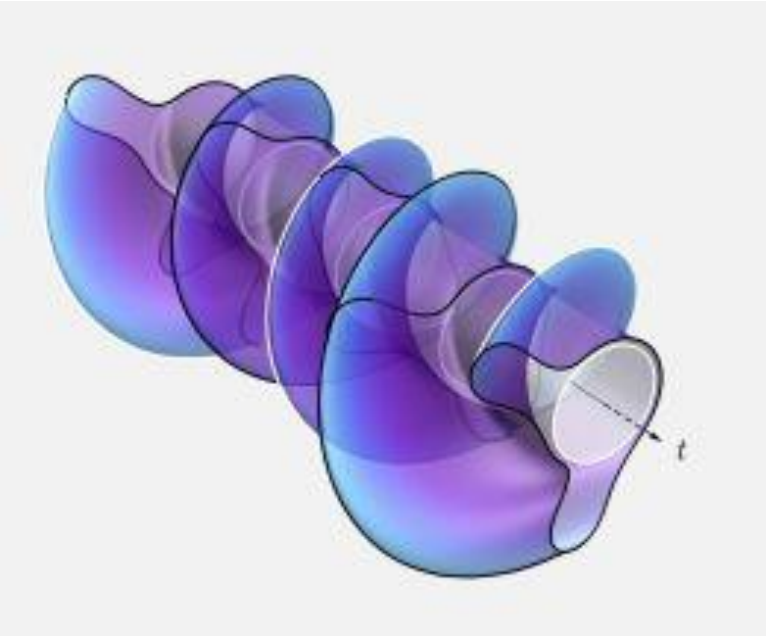
University of Strathclyde Glasgow

36th Scottish Fluid Mechanics Meeting

Wednesday 24th May 2023

Organising Committee: Professor Stephen Wilson (Chair), Dr Joseph Cousins, Professor Apala Majumdar, Professor Mikhail Osipov, Dr Alex Wray



Sponsored by

DANTEC DYNAMICS

EDINBURGH MATHEMATICAL SOCIETY

Effect of extracellular matrix on tissue hydraulic permeability of the brain tumour

Yi Yang, Yingfang Zhou, Dubravka Pokrajac, Wenbo Zhan*

School of Engineering, King's College, University of Aberdeen, Aberdeen AB24 3UE, United Kingdom

Correspondence: Dr Wenbo Zhan, Tel: +44 (0)1224 272511, E-mail: w.zhan@abdn.ac.uk

Preference: Oral presentation (Yi Yang)

Abstract

Glioblastoma (GBM) is the most common primary malignant brain cancer in adults. With a high 5-year mortality rate of more than 90%, GBM is extraordinarily challenging to treat in clinical practice. This disappointing efficacy can partially be attributed to the highly limited drug penetration in tumour extracellular space (ECS). Up to 70% of drugs accumulate within a 5 μm distance from the capillary surface. The rapid accumulation might be related to significantly increased concentration of hyaluronan (HA) in the ECS of brain tumours, compared to brain normal tissues. However, how the presence of HA affects tissue transport properties and interstitial fluid flow remains unclear.

In this study, mathematical modelling was applied to probe the relationship between tissue hydraulic permeability of the brain tumour and HA concentration. The model geometry (Fig.1) was based on an idealised 3D tumour microstructure reconstructed using the real size of brain tumour cells and tissue porosity.

The prediction accuracy of the established model is demonstrated by the good agreement between modelling and experimental results. The tissue hydraulic permeability was found negatively correlated to the HA concentration (Fig.2). This means that interstitial fluid flows more easily through the ECS when the HA concentration is low. The results from this study can contribute to the understanding of the tumour microenvironment and provide support for the following study on drug transport and distribution in brain tumours.

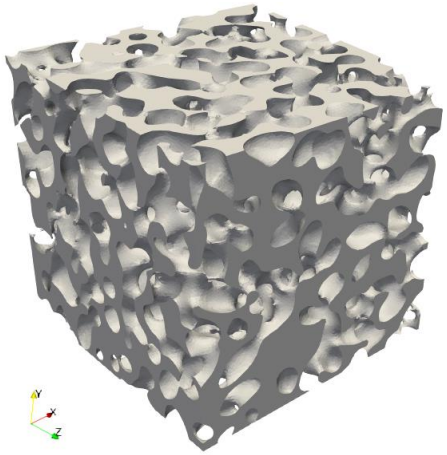


Fig.1. A representative reconstructed microstructure (200 μm)

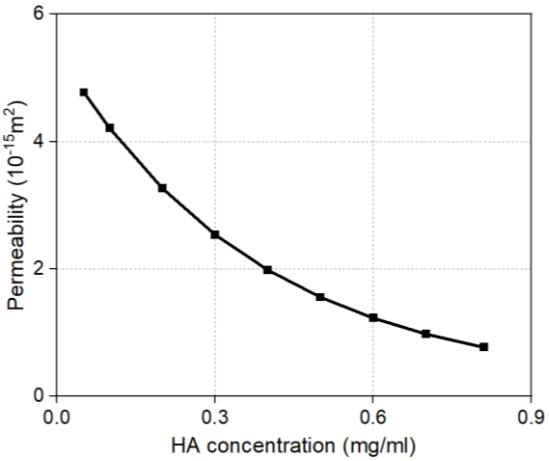


Fig.2. The relationship between the tumour tissue hydraulic permeability with concentrations of HA