Neurological Diseases, Brain Dynamics and Mathematical Modelling

Eleuterio F. Toro
Laboratory of Applied Mathematics
University of Trento, Italy.
Email: eleuterio.toro@unitn.it Webpage: eleuteriotoro.com

I first describe a range of neurological diseases thought to be associated to disturbed brain venous haemodynamics resulting from extracranial venous strictures, of which a prominent example is Multiple Sclerosis [1]. It has been hypothesized that such extracranial venous anomalies hamper venous return, cause intracranial venous hypertension and may trigger a complex chain of events leading to demyelination and ultimately to disability. Other neuropathologies are currently being re-examined under this vascular framework, emphasizing the importance of underlying biophysical phenomena and encouraging a multidisciplinary approach to study them. Examples include Parkinson's, Alzheimer's and Meniere's disease.

Then I describe a mathematical model for the entire human circulation, a simulation tool to study some aspects of brain haemodynamics [1], [2], with particular attention paid to the venous and cerebrospinal systems, with the aim of contributing to elucidate some of the issues raised by the vascular theory. Mathematical and numerical challenges associated with the model are pointed out. Our mathematical simulations tend to support the vascular theory, though experimental data is lacking [2]-[5]. Potential implications are discussed.

I conclude this talk by briefly referring to the very recent discovery of a *brain lymphatic system* [6],[7], which added to the by now a well established *glymphatic system,* begins to configure a coherent biophysical picture that may shed light on the causes and potential cure of a broad class of neurological diseases. Our current research efforts on mathematical modelling, motivated by these discoveries, are also mentioned.

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