Computer simulation of blood flow in the intra/extra cranial venous system in humans with multiple sclerosis and the CCSVI condition

Summary and aims of the research programme

This research programme is motivated by the recently proposed association between multiple sclerosis (MS) and a vascular anomaly termed chronic cerebro-spinal venous insufficiency (CCSVI) by Zamboni and collaborators. The CCSVI condition is characterized by the presence of obstructions of various kinds in the extracranial veins. Such obstructions prevent a normal drainage of blood from the brain to the heart. CCSVI is present in a relevant number of MS patients and such occurrence is of great clinical interest. However such association does not yet explain the gestation of MS, although it has been hypothesized a potential link between the altered fluid dynamics, transport and deposition of iron, disruption of the brain- blood barrier and penetration of auto-aggressive immune cells into the CNS, with the known consequences of demyelization of the nerve's sheath.

This research programme is limited to a theoretical study of the bio-fluid dynamical aspects of the CCSVI condition by means of a mathematical model. The aim is to further investigate the physical phenomena observed empirically by Zamboni and collaborators by means of colour Doppler sonography measurements. The research programme has several distinct parts, including (1) the determination of the computational domain, (2) the construction of a mathematical model for the fluid dynamical problem and (3) the development of computational methods that would allow a computer simulation of the phenomena of interest. There would follow a (4) comparison between theoretical simulation and empirical measurements, (5) use of the theoretical model to study of Zamboni's protocol for testing the CCSVI condition and (6) the formulation of recommendations. If successful, the theoretical tool developed could subsequently be used as the basis for further research, for example to assist potential surgery and to perhaps even associate the anomalous fluid dynamics to the anomalous behaviour of the brain blood barrier, an accepted component of multiple sclerosis.

Given the highly interdisciplinary character of the proposal we have taken good care of assembling a team that involves applied mathematicians, engineers, physicists and medical doctors fully engaged with the CCSVI phenomena and multiple sclerosis.

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