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Constitutive Modelling of Brain Tissue is based on Basic Science for Clinical Composite Tissue Transplantation

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Description

Brain tissue is not only one of the most important but also the most complex and compliant tissue in the human body. While long underestimated, increasing evidence confirms that mechanics plays a critical role in modulating brain function and dysfunction. Computational simulations based on the field equations of nonlinear continuum mechanics–can provide important insights into the fundamental mechanisms of brain injury and disease that go beyond what typical diagnostic instruments can detect. Mechanical models capable of capturing the complex and distinctive properties of this ultra-soft, diverse, and dynamic tissue, on the other hand, are required for realistic numerical predictions [1].

We provide relevant mechanical modelling methodologies that are as complex as necessary but as simple as possible, depending on the application of interest. This detailed review will inspire the design of new experiments on the one hand, and assist the selection of acceptable constitutive models for specific applications on the other. To execute successful predictive simulations, mechanical models that reflect the complicated behaviour of neural tissues and are precisely calibrated with trustworthy and extensive experimental data are essential [2]. Finally, mathematical modelling and computer simulations of the brain are beneficial to both the biological and clinical communities, with applications spanning from illness prediction and damage risk estimation to surgical procedure planning. One of the most complicated tissues in the human body is brain tissue [3].

The World Health Organization has listed neurological illnesses, such as stroke, encephalitis, dementias, and epilepsy, as one of the significant public health concerns. The repercussions of neurotrauma are also a hazard, with over 2 million persons impacted by traumatic brain injury each year while neuroscience research has mostly focused on electrophysiological, biochemical, molecular, and genetic studies in recent decades. Recent research has found that mechanics is important for neural function and dysfunction External mechanical stresses can harm brain tissue after traumatic brain or spinal cord injury but mechanical signals can also govern disease genesis and progression through nerve cell mechanosensation example, mechanics appear to influence not just cortical folding but also tumour cell migration and cell death during mammalian brain development Cortical malformations associated with schizophrenia autism and or cell death in Alzheimer's patients associated with dementia is caused by physiological changes in the mechanical environment [4].

Computational modelling and tailored simulations can provide important details about the systems at work during damage and disease. Such prediction models not only eliminate the need for human and animal research, but also allow for the development of novel treatment techniques and comprehensive surgical planning [5]. However, realistic predictions of mechanobiological processes in the brain necessitate sophisticated mechanical models that capture the ultra-soft, highly adaptable, and heterogeneous tissue's complex and distinctive properties. While significant attempts have been made to mechanically mimic the behaviour of brain tissue in health and sickness inconsistent experimental results have slowed research and generated confusion and delays.

Conflict of interest

None.

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