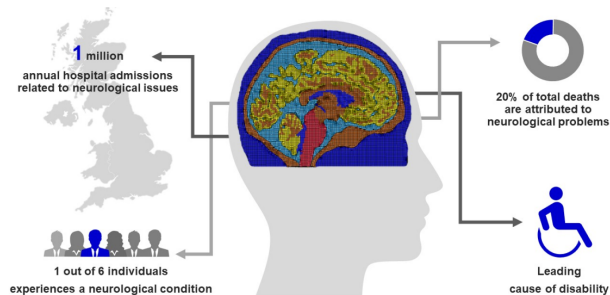


Computational Models of Brain: Toward a Better Understanding of Neurological Conditions

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Introduction

Neurological disorders and injuries encompass a wide range of conditions, including stroke, traumatic brain injury, Alzheimer's disease, and Normal Pressure Hydrocephalus (NPH). While some of them can result in immediate death, others lead to a gradual decline in the function of the brain. In the UK, near 140,000 deaths per year are attributed to them.



Biomechanics-based computational models serve as powerful tools for enhancing our understanding of neurological conditions. In disorders like NPH, where ventricular expansion occurs (leading to mechanical loads playing a significant role), these models can provide valuable insights into how biomechanical forces contribute to brain-related abnormal conditions.

Methods

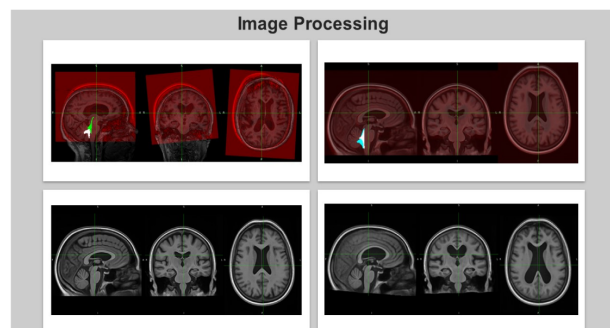
MRI Image Processing and Analysis MRI images were acquired from 16 patients with Normal Pressure Hydrocephalus (NPH) (11 male, 5 female) and 30 healthy individuals (15 male, 15 female). These images were processed and analyzed to extract the necessary information for developing a computational model.

Mesh Generation At the HEAD Lab of Imperial College, image-based head models were created. These models serve as representations of the human head for further analysis.

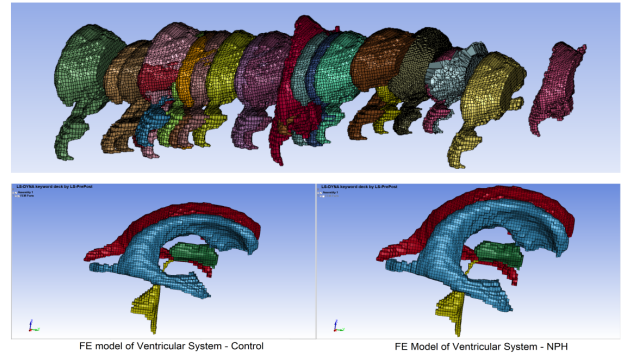
Finite Element Analysis (FEA) Computational and numerical methods were used to simulate NPH disorder. Variables such as strain were investigated as indicators of damage.

Results

More than 30 distinct ventricular models were generated using a combination of rigid, linear, and non-linear registration methods. These techniques significantly improved the geometrical accuracy of the models (up to 80 % respect to ventricles' volume). Subsequently, the strain distribution was calculated during ventricular expansion to identify regions at high risk of damage.

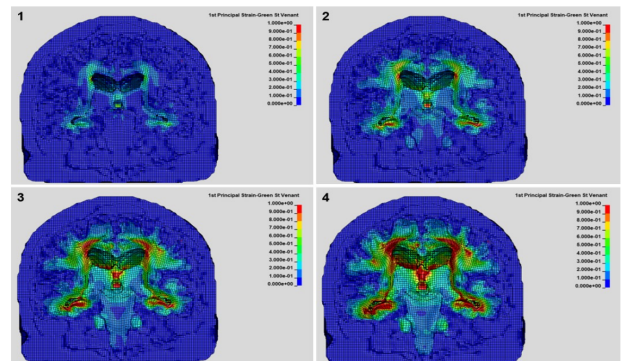


“ Virtual models have the potential to assist in **designing more optimized interventions for neurological conditions.**”



Discussion

The strain distribution illustrates that brain tissue near the ventricular boundary is at the highest risk of damage. Although further efforts are needed to improve geometrical accuracy to over 80%, the current outputs show the potentials of this computational model for the **determination of a threshold for brain damage.**



Conclusion

Computational models can aid medical scientists and surgeons in gaining a **deeper understanding of neurological conditions** and potentially **designing more effective surgical procedures.** These models show the potential to significantly impact the lives of people who suffer from brain-related issues, ultimately contributing to a better quality of life for everyone.

Bio



Vahid is a PhD student currently working on brain injuries and disorders, with funding from the Dyson School of Design and Engineering. Prior to joining Imperial, he collaborated with cancer institutes and hospitals on cancer detection and treatment since 2015. His passion lies in biomechanical engineering and its transformative applications for addressing complex medical challenges.

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