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Computational modelling of neurovascular injuries to investigate the link between biomechanics and injury patterns

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Neurovascular Injury is a very frequent feature after Traumatic Brain Injury (TBI) and can result in significant health problems. The cerebral vascular reaction to force impact during head collisions remains unclear because mechanical properties aren't closely defined yet. Thresholds which, when exceeded, lead to vascular ruptures causing hemorrhages or Cerebral Microbleeds (CMBs) are not determined. The goal of the presented research is to further the knowledge about the biomechanical brain mechanisms by accurately investigating a small number of case studies. Therefore, computational models are developed to simulate real world accidents. Based on video recordings, the accidents scenarios were recreated using the multybody software Madymo receiving head impact velocities and accelerations of the patients involved. Subsequently, a comprehensive brain vessel model is run to display strain and stress characteristics of the neurovascularity following these kinematics. The relationship between biomechanics and clinical outcome can be examined comparing highest strain regions of the brain simulation and injury patterns envisioned by the patients' neuroimages.

This work excels due to the precise accident reconstruction, the blood vessel (Finite Element) FE brain model and the detailed accident data. The benefit from understanding the influence of external forces on the brain vessels lies in increasing the safety of protective equipment like helmets in order to prevent TBI.

Biography

Nikolaus Wischmann has an academical and professional background in Industrial Engineering, major in mechanics and computation. As part of an educational reorientation towards Neurotechnology, he joined the multidisciplinary HEAD lab research team at Imperial College London in 2020. The lab explores the field of injury biomechanics with a special focus on TBI and its prevention. He is also founder and director of a startup coached by Imperial's Enterprise lab, aiming to make Brain Machine Interfaces accessible to the mass market and enabling everyday neuroapplications. The startup works on universal AI solutions to decode data recorded by commercial brain sensoring devices.

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