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Editorial

Numerical Modelling and Simulation Applied to Head Trauma

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Traumatic brain injury (TBI) is one of the leading causes of death and disability. Road traffic accidents, sports, assaults, and accidents at work and during recreational activities are the major sources. In order to better understand the mechanisms of TBI, numerical models of the human head have been developed. Since the late 1970s, finite element head models have evolved from simple geometries to models with detailed geometric descriptions of anatomical features, with complex constitutive modelling and numerical formulations being used. Complex and accurate human head modelling is possible because of today's numerical methods and computational efficiency.

The numerical models are a powerful tool for brain injury analysis and prevention, safety gear optimization, accident analyses, and reconstruction and forensic biomechanics. These allow the researchers to have an accurate computational-based prediction of brain injuries by relating the results to medical investigations based on autopsies of corpses involved in real accidents. Numerical modelling and simulation have also been used for head impact tests regarding standards and regulations (e.g., headforms, dummies, impact tests) as a form of optimization before physical testing.

This Special Issue collects a set of contributions to state of the art of numerical head models and their application in the study of head impacts based on real-world scenarios such as accidents, reconstructions, and analyses of safety gear. Therefore, this publication presents a set of contributions in the field of numerical modelling and simulation applied, for instance, to safety standards and regulations, focusing on head impact.

In this Special Issue, the authors of selected works contributed to the topics referred to above. Therefore, the contents of their work can be synthesized as follows—by chronological order of publication:

- Fernandes et al. [1] demonstrated the potential of using computational models in helmet design by evaluating the efficacy of a certified motorcycle helmet through virtual testing by using finite element models of both a helmet and a human head. The latter was used as an injury prediction tool to assess the helmet's safety performance. Results showed a risk of brain injury, highlighting the need to revise and improve the ECE R22.05 standard safety requirements. This article was selected as the cover story ("*Finite Element Head Models: A Computational Approach for Helmet Design*") of *Math. Comput. Appl.*, Volume 25, Issue 1.
- Hosseini-Farid et al. [2], also using a finite element human head model, investigated the biomechanics of both helmeted and unhelmeted head impact and blast shock waves, leading to TBI. The results from this study provided insights into the typical strain rates in the head structures found in these events.
- Toma et al. [3] studied the interaction of cerebrospinal fluid (CSF) with the brain parenchyma in an impact scenario (knock-out punch), also employing a finite element head model, using smoothed particle hydrodynamics to simulate CSF. Results showed the concussive mechanism of injury, demonstrating the brain parenchyma as the location with the highest stresses. This article was selected as the cover story

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(“*Predicting Concussion Symptoms Using Computer Simulations*”) of *Math. Comput. Appl.*, Volume 25, Issue 2.

- Bastien et al. [4], also resorting to a computational model of the human brain, presented an organ trauma model to predict brains’ white and grey matter injuries. This trauma model was used to model the fatal fall of a 63-year-old male, achieving comparable predictions compared to post-mortem data.

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