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The Ocular Mathematical Virtual Simulator: a sensitivity analysis study

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Optic neuropathies such as glaucoma are often late-onset, progressive and incurable diseases.
Despite the recent progress in clinical research, there are still numerous open questions regarding the etiology of these disorders and their pathophysiology.
Furthermore, data on ocular posterior tissues are difficult to estimate noninvasively and their clinical interpretation remains challenging due to the interaction among multiple factors that are not easily isolated.
The recent use of mathematical models applied to biomedical problems has helped unveiling complex mechanisms of the human physiology.
In this very compelling context, my PhD thesis was devoted to designing a mathematical and computational model coupling tissue perfusion and biomechanics within the human eye.
I have developed a patient-specific Ocular Mathematical Virtual Simulator (OMVS), which is able to disentangle multiscale and multiphysics factors in an accessible environment by employing advanced and innovative mathematical models and numerical methods.
The proposed framework may serve as a complementary method for data analysis and visualization for clinical and experimental research, and a training application for educational purposes.
In my presentation, I would like to introduce this complex framework and its clinical, numerical and computational challenges.
Subsequently I will report some interesting results produced by a variance-based sensitivity analysis performed on this mathematical model. In particular, I will focus on the effect of intraocular pressure and systemic blood pressure on the ocular posterior tissue vasculature.
The combination of a physically-based model with experiments-based stochastic input allows us to gain a better understanding of the physiological system, accounting both for the driving mechanisms and the data variability.
Additionally, the results obtained with this analysis support the validity of the model and its clinical application.

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