Modeling the air puff test in the human cornea with a meshfree fluid-structure interaction approach

Anna Pandolfi, Andrea Montanino
Politecnico di Milano
anna.pandolfi@polimi.it, andrea.montanino@polimi.it
Maurizio Angelillo
Università di Salerno
mangelillo@unisa.it

Abstract

We present a numerical approach that couples an analytical structural model and a meshfree discretization to simulate the anterior chamber of the eye undergoing the air puff test. The air puff test is a dynamical in-vivo investigative procedure commonly utilized in ophthalmology to estimate the intraocular pressure (IOP). Potentially the test, quick and painless, could be combined with inverse numerical methods to characterize the mechanical properties of the human cornea [1]. The dynamical nature of the test induces an interaction between the cornea and the aqueous humor, a fluid filling the narrow space between cornea and iris, with an expected strong influence on the outcomes of the test. While the modelling of the solid cornea has reached considerable levels of complexity and fidelity to the patient specific geometry, in the literature scant attention has been paid to the aqueous humor, and no models accounting for the physically correct fluid-solid interaction are currently available. The present study aims at covering this gap, by proposing a simplified numerical approach based on a two-dimensional axis-symmetric geometry. We describe the cornea with an analytical membrane model and discretize the fluid with a meshfree particle approach. The solid material is assumed to be nonlinear elastic and isotropic. We observe a noticeable influence of the fluid on the dynamics of the cornea. We quantify the influence of the different model and test parameters by means of a parametric analysis [2] .

References

[1] I. Simonini, M. Angelillo, and A. Pandolfi, Theoretical and numerical analysis of the corneal air puff test, *Journal of the Mechanics and Physics of Solids*, 93:118-134, 2016.

[2] A. Montanino, M. Angelillo, and A. Pandolfi, Modeling the air puff test in the human cornea with a meshfree fluid-structure interaction approach, *Journal of Mechanical Behavior of Biomedical Materials*, Submitted.