# Application of the Modified Finite Particle Method to the simulation of the corneal air puff test

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## ABSTRACT

The air puff is a contactless tonometer commonly used in ophthalmology to determine the mechanical properties of the human cornea and the intraocular pressure (IOP). The test consists in hitting the external corneal surface with an impulsive air jet, which makes the cornea snap from its original convex shape to a locally concave configuration. Then the medical instrument records same parameters of interests, from which the requested properties are determined.

The numerical modeling of the air puff test is a challenging task, since it involves many parameters whose identification is not straightforward (i.e., the material model and its parameters; geometrical properties, etc.).

Moreover, an important role in the modeling of the puff test is played by the humor aqueous which fills the ocular anterior chamber, determining a local pressure increment and an over-stiffness of the whole ocular structure. In previous works [1, 2], the presence of the fluid was simulated using added masses to nodes on the interior surface of the cornea.

In the present work we focus on the effect of the presence of the fluid inside the anterior chamber, and explore, through parametric analyses, the effects of the initial IOP, of the main elasticity modulus of the corneal material, and the effects of the peak external air puff pressure. The geometry of the cornea, for sake of simplicity, is reduced to a spherical sector, and it is studied exploiting the axial symmetry; the material is simplified ignoring the complex fibril architecture of the corneal structure, and considering an anisotropic Fung material. The fluid is modeled using the Modified Finite Particle Method [3], a numerical method particularly suitable for studying the fluid motion, due to its Lagrangian nature, and therefore advantageous for problems of Fluid-Structure Interaction.

The obtained results confirm the absolute need of the fluid modeling to capture important features of the puff test, and the comparability of our results with the output provided by the ocular response analyzer.

### References

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