8th World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

NUMERICAL EVALUATION OF THE MECHANICAL RESPONSE TO LASER REFRACTIVE CORNEAL SURGERY

*** Anna Pandolfi[1], Giorgio Fotia[2], and Federico Manganiello[1]**

[1] Politecnico di Milano
Piazza Leonardo da Vinci 32
20133 Milano, Italy
pandolfi@stru.polimi.it
www.stru.polimi.it/people/pandolfi/index.plp

[2] CRS4 Bioinformatics Lab
Edificio 3, Loc. Pixinamanna
09010 Pula, Italy
Giorgio.Fotia@crs4.it
www.bioinformatica.crs4.org/Members/giorgiofotia

Key Words: *Human Cornea, Refractive Power, Ablation Profiles, Refractive Corneal Surgery, Finite Elements, Fiber Reinforced Material.*

ABSTRACT

The finite element method is used to simulate the effective change in the shape of the human cornea resulting from ablation of stromal tissue and to evaluate the change in the dioptric power resulting from laser refractive corneal surgery.

A 3D parametrized numerical model of the human cornea is developed. The solid model based on the idealized geometry of a simulated patient is discretized into finite elements by an automatic procedure which recovers the estimated undeformed configuration. A two-fiber reinforced hyperelastic material model, which accounts for the organization of the anisotropic collagen structure, is adopted to describe the stromal tissue. For the simulation of mechanical outcomes of the surgical correction of myopic and astigmatic eyes, a corneal reshaping procedure based on standard ablation profiles is included into the code. The proposed cornea model may be adapted to individual cases in terms of material properties and of geometry.

Numerical results provide the postoperative shape of the cornea, a comparison between the preoperative and the postoperative refractive power, and the distribution of the stress and the strain fields through the stromal tissue.

Examples of application demonstrate the possibility of the proposed model to reproduce the geometrical outcomes of the refractive surgery. The numerical approach was able to predict the expected refractive correction as computed by standard ablation profiles.

REFERENCES

[1] A. Pandolfi and F. Manganiello. “A model for the human cornea: constitutive formulation and numerical analysis”. *Biomechanics and Modeling in Mechanobiology* , Vol.5, 237–246, 2006.

[2] A. Pandolfi, G. Fotia, and F. Manganiello. “Finite Element Simulations of Laser Refractive Corneal Surgery”. *Engineering with Computer*, in press, 2007.