15th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering
and
3rd Conference on Imaging and Visualization
**CMBBE 2018**
*P. R. Fernandes and J. M. Tavares (Editors)*

**Abstract ID-100**

# OPTIMIZATION OF SURGICAL PARAMETERS BASED ON PATIENT-SPECIFIC MODELS - APPLICATION TO CATARACT SURGERY

***Oskar Truffer[(1)], Harald Studer[(2)], Elena Businaro[(2)], Philippe Büchler[(1)]***

[(1)]**University of Bern, Switzerland**
*oskar.truffer@istb.unibe.ch, philippe.buechler@istb.unibe.ch*

[(2)]**Optimo Medical AG, Switzerland**
*harald.studer@optimo-medical.com, elena.businaro@optimo-medical.com*

**Keywords:** Arcuate Keratotomy, Opthalmology, Optimization, Nomogram, Refractive Surgery, Cataract, AK, Mechanical Simulation, Cornea, parameter-optimization

**Summary:** Introduction: Degradation or loss of vision greatly impacts quality of life. Almost 250 million people worldwide are visually impaired, which in 2009 had an estimated economic impact of $268.8B.
The optical properties of the cornea are majorly determined by the mechanical balance between intraocular pressure and the internal stresses of the corneal tissue. Interventions such as cataract surgery (~4.3 million per year in the US) alter this balance and can thereby compromise visual acuity by local incisions performed in the cornea as part of the intervention. Typically, Arcuate Keratotomy (AK) consists of additional incisions in the cornea to correct astigmatism following replacement of the pathologic crystalline lens.
Clinically, the cutting parameters, such as the depth or length of the incisions, are derived from clinical nomograms, which are lookup tables based on statistical models. Unfortunately, in most cases (~50%) astigmatism remains under-corrected (>0.5D).
Methods: We propose to rely on a previously validated numerical model of the cornea to optimize the visual outcome for each individual patient. A simulation pipeline has been developed to perform AK on a large number of patient datasets; more than 600 patients representing candidates for cataract intervention have been included. For each patient dataset, the simulation was performed using the cutting parameters suggested by a nomogram and compared with the results obtained using a parameter-optimization routine.
Results: Surgery outcome is more reliable using model-based optimization; while the resulting post-simulation residual astigmatism for the nomogram group was +0.36D±0.29 (SD), the group with optimized parameters had a residual astigmatism of +0.33±0.06 (SD).
Discussion: Results showed some key advantages of the numerically optimized parameters over nomograms. First, the numerical optimization controls the steep axis of the astigmatism, preventing over-correction. Only ~1% of simulations changed the steep axis more than 30°. In addition, in contrast to nomograms, the optimization allows targeting a specific post-operative astigmatism, which provides the surgeon with more control. Patient-specific optimization of surgical parameters showed promising results for AK surgery. However, the study is purely numerical and clinical validation is needed to demonstrate clinical applicability.