BIOMECHANICS OF CORNEA

A SUMMER INTERNSHIP PROJECT REPORT

Submitted by

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INTRODUCTION:

The cornea is the transparent front part of the eye that covers the iris, pupil, and anterior chamber. The cornea, with the anterior chamber and lens, refracts light, with the cornea accounting for approximately two-thirds of the eye's total optical power.

CONTENTS:

OCULAR REFRACTION:

- Cornea is the first cellular surface of eye's optical system and it is transparent.
- Ocular refraction is the change in the direction of propagation of light rays crossing of transparent media (cornea) and refractive eye.
- The object is refracted at lens.
- The focus of the object is formed at retina, then we can see the image of that object.

CURVATURE OF CORNEA:

- The outer surface of the cornea is called "Anterior cornea".
- The inner surface of the cornea is called “Posterior cornea”.
- The distance from anterior cornea to the lens is called “Anterior chamber depth”.
- Eye color is defined by “Iris”. Iris is a thin, circular structure in eye.
STRUCTURE:

- Cornea consists of five layers.
- The epithelium and endothelium layers do not directly contribute to corneal thickness.
- Bowman’s layer gives corneal stability.
- Stroma represents the largest part of the cornea and mainly defining biomechanical properties of cornea.
- Descemet’s layer contributes significantly to corneal stiffness.

IOP:

- Generally in case of Glaucoma (eye disease), the optic nerve of the eye (connected to the brain) damage.
- The reason of glaucoma is diabetes.
In glaucoma, the fluid in eye gradually build up, the drainage of fluid does not occur properly and increase the pressure in eye, this pressure is called "intraocular pressure (IOP)".

**ABAQUS SOFTWARE:**

**ABAQUS** is a software suite for finite element analysis and computer-aided engineering. The name and logo of this software are based on the abacus calculation tool. The Abaqus product suite consists of five core software products:

1. **Abaqus/CAE**, or "Complete Abaqus Environment". It is a software application used for both the modelling and analysis of mechanical components and assemblies and visualizing the finite element analysis result. A subset of Abaqus/CAE including only the post-processing module can be launched independently in the Abaqus/Viewer product.
2. **Abaqus/Standard**, a general-purpose Finite-Element analyser that employs implicit integration scheme.
3. **Abaqus/Explicit**, a special-purpose Finite-Element analyser that employs explicit integration scheme to solve highly nonlinear systems with many complex contacts under transient loads.
4. **Abaqus/CFD**, a Computational Fluid Dynamics software application which provides advanced computational fluid dynamics capabilities with extensive support for preprocessing and postprocessing provided in Abaqus/CAE.
5. **Abaqus/Electromagnetic**, a Computational electromagnetics software application which solves advanced computational electromagnetic problems.
MODELING OF CORNEA:

- The structural model of cornea can be approached by creating a 3D shell model.
- The material is isotropic.
- Value of Intra Ocular Pressure = 15 mm of Hg
  \[=0.00196 \text{ MPa}\]
- Young’s modulus of elasticity, \( E = 0.3 \text{ MPa} \)
- Poisson’s ratio = 0.49

GEOMETRY:

- The structure of human cornea has a nonuniform curvature with variable thickness throughout.
- This is thinner at the center and thickens towards the edges.
- 3D corneal models meshed into hexahedral or tetrahedral elements.
BOUNDARY CONDITIONS:

- For boundary condition, roller support is provided at the edges inclined at 40° with respect to the horizontal axis to represent cornea-limbus behavior.

MATERIAL MODELS:

- Finite element model of cornea is linear elastic model, homogeneous and isotropic material.
CONCLUSION:

- From Abaqus software we observe that the contour levels of the maximum Cauchy stress are about 0.20MPa for a cornea at 15mm Hg Intra Ocular Pressure.
- One main benefit of using Abaqus is the ability to operate between the implicit solver, generally used for stress, strain simulation.

**THANK YOU**