4-2020

Alexithymia Symptoms Are Not Associated With Childhood Trauma or CRHR1 rs110402 Genotype

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Perturbed Stress Field of the Human Lens Capsule After Cataract Surgery

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Presented for UCARE Spring Research Fair 2020

INTRODUCTION

- Cataract surgery involves the removal of opaque lens fibers from the lens capsule, which are replaced by an intraocular lens (IOL).
- Current IOLs cannot restore youthful accommodation and are susceptible to secondary cataracts.
- Previous work by our group hypothesized the disturbance of the native stress field caused by cataract surgery drives the errant cell behavior responsible for secondary cataracts [1].

MOTIVATION

- The goal of this study was to develop the first fully 3-D finite element model of the post-surgical lens capsule with an implanted tension ring and, separately, a monofocal IOL to quantify altered stresses after cataract surgery compared to the native lens capsule.

METHODS

- Finite element models of the native lens capsule, the post-surgical lens capsule, and both implants were developed in Abaqus Standard 2019.
- The capsule was prescribed regionally varying anisotropic hyperelastic material properties according to the Holzapfel strain energy function [2], as well as a regionally varying thickness [3].
- The native lens capsule was pressurized to 2 mmHg with a 1.15 kPa traction at the equator.
- The post-surgical capsule was given a flattened configuration [4] and initially stress-free.

RESULTS

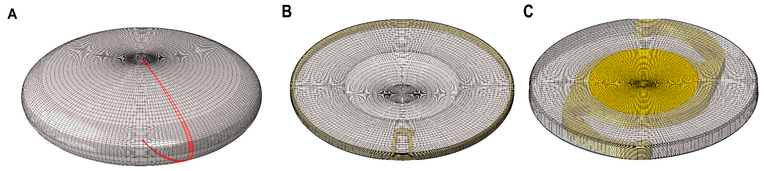

Figure 1: (A) Finite element model of the native lens capsule. Native Cauchy stress values in the circumferential and meridional direction were measured at the highlighted meridian. (B) Finite element model of the post-surgical lens capsule with an implanted tension ring. (C) Finite element model of the post-surgical lens capsule with an implanted IOL.

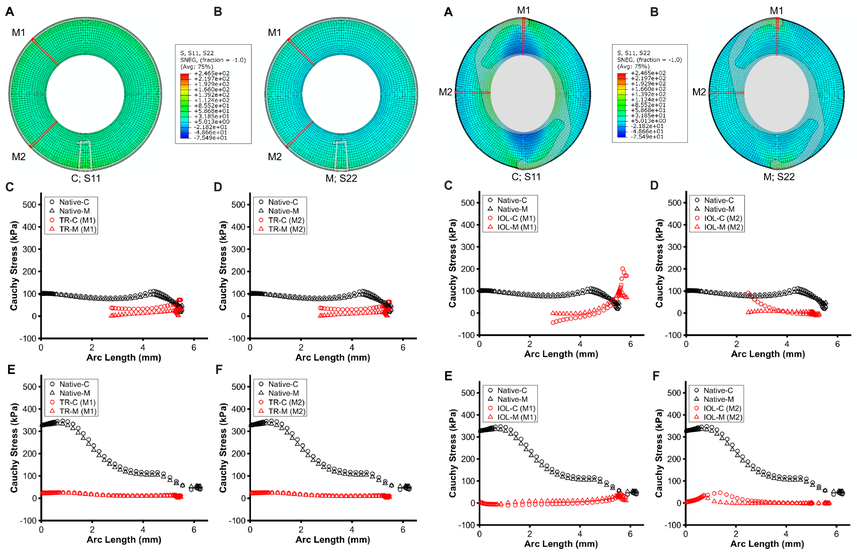

Figure 2: Contour plots of (A) circumferential, C, and (B) meridional, M, Cauchy stress in the anterior portion of the post-surgical lens capsule with an implanted tension ring. Scatter plots comparing the native stress field (black symbols) to the post-surgical stress field (red symbols) in the (C and D) anterior and (E and F) posterior along two meridians, M1 and M2.

Figure 3: Contour plots of (A) circumferential, C, and (B) meridional, M, Cauchy stress in the anterior portion of the post-surgical lens capsule with an implanted IOL. Scatter plots comparing the native stress field (black symbols) to the post-surgical stress field (red symbols) in the (C and D) anterior and (E and F) posterior along two meridians, M1 and M2.

DISCUSSION

- The native capsule model shows a highly uniform equibiaxial stress field in the anterior portion of the capsule and a non-uniform equibiaxial stress field in the posterior.
- The post-surgical model with an implanted tension ring demonstrates a reduced stress field that remains fairly equibiaxial. The stress field is also axisymmetric, as shown by the nearly identical scatter plots for the anterior and posterior stress fields.
- The post-surgical model with an implanted IOL demonstrates a mostly reduced, non-equibiaxial, and non-axisymmetric stress field with significant increases in stress near the equator in the anterior portion of the capsule.

FUTURE WORK

- Couple presented model with remodeling framework previously developed by our group [1] to predict long-term cellular response after surgery with implant.
- Such predictive capabilities may lead to improved IOL designs, specifically those with an effective accommodative feature.

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