ANALYSIS OF BIOMECHANICAL RESPONSE AFTER CORNEAL CROSSLINKING WITH DIFFERENT FLUENCE LEVELS

Isaak Fischinger, MD[1,2,3], Sophia A. Reifeltshammer, MD[2,3], Theo G. Seiler, MD [4, 5,6], Malavika H. Nambiar, MSc[7,8], Philippe Büchler, PhD[7], Jascha Wendelstein, MD[2,3,5], Matthias Bolz, MD[2,3]

1. Augentagesklinik Spreebogen, Berlin, Germany[1];

2. Klinik für Augenheilkunde, Kepler Universitätsklinikum, Linz, Austria[2;]

3. Johannes Kepler Universität Linz, Medizinische Fakultät, Linz, Austria[3];

4. Klinik für Augenheilkunde, Universitätsklinkum Düsseldorf, Germany[4];

5. Institut für Refraktive und Ophthalmo-Chirurgie (IROC), Zürich, Switzerland[5];

6. Department of Ophthalmology, Inselspital Bern, University of Bern, Switzerland[6];

7. ARTORG Center for Biomedical Engineering Research, University of Bern, Bern, Switzerland[7];

8. Graduate School for Cellular and Biomedical Sciences, University of Bern, Switzerland[8]

Introduction

To date corneal crosslinking (CXL) is the only treatment that halts the progression of keratoconus by increasing the stiffness to the weakened corneal stroma using Riboflavin and UV-A light to induce collagen crosslinks[1-3] . Modifications of the original CXL protocols have been introduced by adjusting one or both factors, trying to optimize the outcome of the procedure[4-6]. To determine the biomechanical response of CXL, uniaxial stress-strain measurements on porcine corneas are used by many authors[7, 8], which allows good comparability of results. The aim of this study is to analyze the biomechanical stiffening of porcine corneas after accelerated epi-off corneal crosslinking, with a fluence of 5.4 J/cm² up to 20 J/cm² in porcine corneas.

Methods

Ninety corneae from freshly enucleated porcine eyes were divided into five groups of 18 each. Group 1 to 4 underwent epi-off CXL using a dextran-based riboflavin solution and an irradiance of 18mW/cm², group 5 served as the control group. Groups 1 to 4 were treated with a total fluence of 20 J/cm², 15 J/cm², 10.8 J/cm² and 5.4 J/cm², respectively. Thereafter, biomechanical measurements were performed on 5 mm wide and 6 mm long strips using an uniaxial material tester. Pachymetry measurements were performed on each cornea.

Results

At 10% strain, the stress was 75%, 56%, 53% and 31% higher in groups 1 to 4 respectively compared to the control group. The Young's modulus was 2.84MPa for group 1, 2.53 MPa for group 2, 2.47 MPa for group 3, 2.12MPa for group 4 and 1.62MPa for the control group. The difference between group 1 to 4 and the control group 5 were statistically significant (p=<0.001; p=<0.001; p=<0.001; p=0.021). In addition, group 1 showed significant more stiffening than group 4 (p=<0.001), no other significant differences were found. Pachymetry measurements revealed no statistically significant differences among the five groups.

Discussion

Additional mechanical stiffening can be achieved by increasing the fluence of the CXL. There was no threshold detected up to 20J/cm². A higher fluence could compensate the weaker effect of accelerated or epi-on CXL procedures.

References

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