A predictive model of UV-A-riboflavin crosslinking treatment on porcine corneas

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Abstract

The crosslinking technique (CXL) is an effective low-risk therapeutic treatment of keratoconus and other ectatic disorders of the human cornea. The effect of corneal CXL is to increase the stiffness of the stroma to prevent the progression of the cornea distortion. Several clinical and experimental studies have shown that the stiffening effects predominantly localise on the anterior portion of the stroma and that the in-depth stiffening distribution is highly dependent on the duration of treatment. Yet, how the stiffening effects distribute through the cornea thickness as a function of the treatment duration is an open question. Here we propose an analytical model of the stiffening profile due to CXL-treatment as a function of the irradiation time. We consider linear and nonlinear variations of the crosslinking effects across the thickness and implement them into a finite element model of the porcine cornea. We present a time-dependent in-depth stiffening profile that allows us to predict the post-operative corneas response to physiological intraocular pressure for different irradiation times. We anticipate that this predictive model will support the development of patient specific 3D models that will allow clinicians to design customised CXL treatment, thus enhancing treatment outcomes.

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