MODIFICATION OF BIOPHYSICAL PROPERTIES OF CORNEAL COLLAGEN FOR TREATMENT OF KERATOCONUS

M. Kohlhaas
Augenklinik, Universitätsklinikum, Fetscherstr. 74, 01307 Dresden, Germany

Keratoconus is an eye disease which leads to corneal deformation caused by reduced stiffness of the corneal stromal layers and resulting in drastic impairment of vision ability. Corneal deformation becomes noticeable after puberty with a prevalence of 1-2/1000 inhabitants. Until now the treatment of choice is a corneal transplantation, with Keratoconus setting 15 % of all indications for corneal transplantation. We investigated several crosslinking techniques in order to prevent progression of corneal bowing, including chemical crosslinking, reduction by aldehyde sugars, and light irradiation. General conditions were a) strong local limitation to the center of the cornea, b) easy handling, c) short treatment time and d) no adverse side effects. Application of riboflavin/UVA met all these requirements and furthermore proved to be the best in situ methode to stiffen the corneal stroma by crosslinking the collageneous fibers. Before treatment the central epithelium had to be removed in an area of 9 mm in diameter in order to allow penetration of riboflavin into the corneal stroma. Then 0.1 % riboflavin solution was dropped onto the corneal surface and irradiated with UVA (370 nm, 3mW/cm²) from two UV-LEDs (divergence of 10°) in a distance of 2 cm for 30 min. The UV-diodes were arranged in such way to irradiate an area of 8 mm in diameter. This ensures that the periphery of the cornea, where limbal stem cells are located, is not influenced by the irradiation. The crosslinking effect was proven by stress-strain measurements with the crosslinked corneas possessing increased stiffness. The treated corneas also showed a slower swelling rate, a higher shrinkage temperature, thickened collagen fibers, and an increased resistance against enzymatic digestion. It could be shown that crosslinking by photochemical reaction under the above described conditions is induced only in the anterior part of the cornea, where 70 % of the UV-irradiation is absorbed, while the inner cell layer of the cornea remains unaffected. Such strengthening of the anterior cornea is sufficient for the treatment of keratoconus. We treated 100 patients in the framework of a clinical trial with satisfying results. Such in situ modification of collagen-containing tissues may as well be of use in bioengineering and biomaterial research.