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Online-Only Material: The eAppendix is available at http://www.archophthalmol.com.

Additional Contributions: Chikako Endo provided technical assistance.

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Depth Profile Study of Abnormal Collagen Orientation in Keratoconus Corneas

In a previous study,[1] we used femtosecond laser technology to cut ex vivo human corneas into anterior, mid, and posterior sections, after which x-ray scatter patterns were obtained at fine intervals over each specimen. Data analysis revealed the predominant orientation of collagen at each sampling site, which was assembled to show the variation in collagen orientation between central and peripheral regions of the cornea and as a function of tissue depth. We hypothesized that the predominantly orthogonal arrangement of collagen (directed toward opposing sets of rectus muscles) in the mid and posterior stroma may help to distribute strain in the cornea by allowing it to withstand the pull of the extraocular muscles. It was also suggested that the more isotropic arrangement in the anterior stroma may play a role in tissue biomechanics by resisting intraocular pressure while at the same time maintaining corneal curvature. This article, in conjunction with our findings of abnormal collagen orientation in full-thickness keratoconus corneas,[2,3] received a great deal of interest from the scientific community and prompted the following question: how does collagen orientation change as a function of tissue depth when the anterior curvature of the cornea is abnormal, as in keratoconus? Herein, we report findings from our investigation aimed at answering this question.

Methods. The Baron chamber used in our previous study[1] was adapted to enable corneal buttons to be clamped in place and inflated (by pumping physiological saline into the posterior compartment) to restore their natural curvature. A button diameter of 8 mm or larger was deemed necessary to ensure tissue stability during this process.

The next step, obtaining fresh, full-thickness, keratoconus buttons of sufficient diameter, proved to be problematic owing to the increasing popularity of deep anterior lamellar keratoplasty. Recently, however, the opportunity arose to examine an 8-mm full-thickness (300-340 μm minus epithelium) keratoconus corneal button with some central scarring and a mean power greater than 51.8 diopters (**Figure 1**). The tissue was obtained in accordance with the tenets of the Declaration of Helsinki and with full informed consent from a 31-year-old patient at the time of penetrating keratoplasty. Using techniques detailed previously,[1] the corneal button was clamped in the chamber and inflated. The central 6.3-mm region of the button was then flattened by the applanation cone and a single cut was made at a depth of 150 μm from the surface using an IntraLase 60-kHz femtosecond laser (Abbott Medical Optics Inc),[1] thus splitting the cornea into anterior and posterior sections of roughly equal thickness. Wide-angle x-ray scattering patterns were collected at 0.25-mm intervals over each cor-

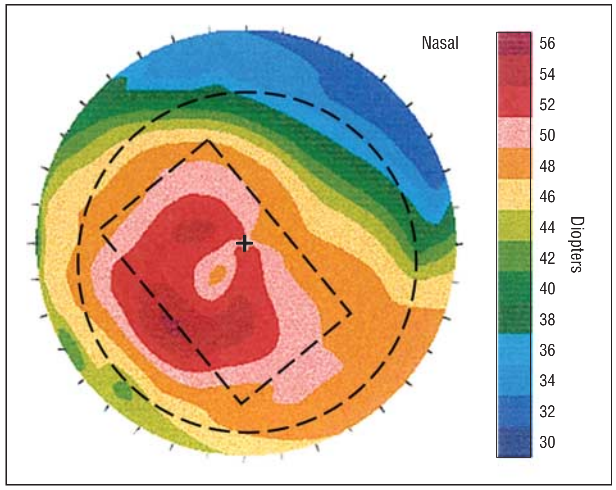

Figure 1. Corneal topography of the keratoconus cornea (recorded 12 years previously).[3] The broken lines show the 6.3-mm region of the cornea cut with the femtosecond laser (circle) and the region of greatest corneal steepening depicted in Figure 2 (rectangle).

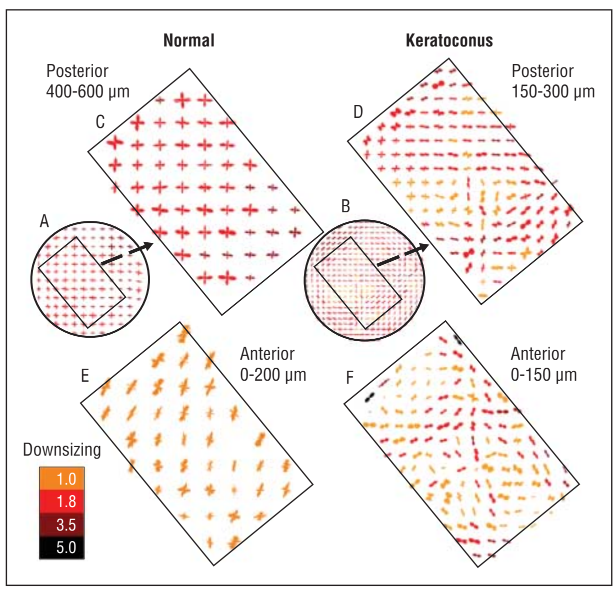

Figure 2. Collagen orientation in the normal (A) and keratoconus (B) posterior stroma (central 6.3 mm). The highlighted regions of the posterior (C and D) and anterior (E and F) stroma are expanded. Large vector plots showing high collagen alignment are downsized (key).

neal section on station I02 at the Diamond Light Source.[2] The data were analyzed[1] to form vector plots—the radial extent of which, in any direction, is proportional to the number of fibrils preferentially aligned in that direction. These were assembled, and the larger plots scaled down, to show the predominant orientation of collagen throughout each tissue section.

Results. Abnormalities in collagen organization were seen in both the anterior and posterior stroma of the keratoconus cornea (**Figure 2**), with the most drastic disruption occurring within the region of greatest corneal steepening (Figure 1). In the posterior stroma, the normal orthogonal predominant orientation of collagen was absent; in the anterior stroma, the usual isotropic arrangement of collagen was replaced with more highly aligned unidirectional collagen.

Comment. The results indicate that a gross rearrangement of lamellae had occurred in both the anterior and posterior regions of the keratoconus corneal stroma (Figure 2). These findings support our belief that the specific arrangement of stromal collagen plays a significant role in the maintenance of normal corneal curvature.

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Dacryops of Krause Gland in the Inferior Fornix in a Child

Dacryops of the accessory lacrimal glands are extremely rare, with only 4 previous cases reported to involve Krause glands in the last 60 years.[1-4] Dacryops of Krause glands have not been reported in the inferior fornix. The cause is often unclear, although numerous causes of secondary dacryops are known.[1-4]

Report of a Case. An otherwise healthy 2-year-old girl had a left lower eyelid mass, noted since age 2 months

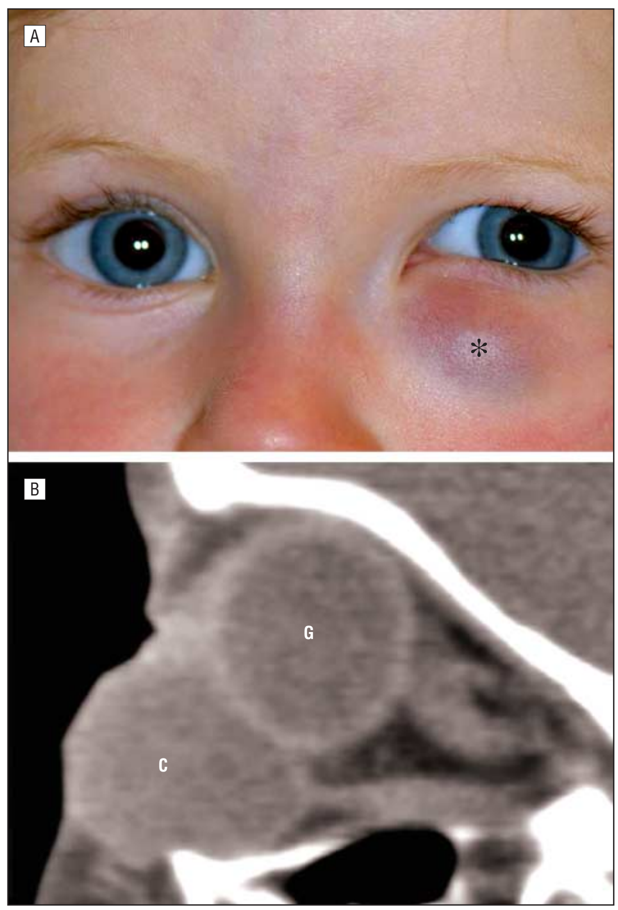

Figure 1. Findings in a 2-year-old girl. A, Left lower eyelid swelling (asterisk). B, Computed tomographic scan shows the cystic nature of the lesion (C) extending inferiorly, with enophthalmos of the left globe (G).