Corneal Cross-Linking in a 4-Year-Old Child With Keratoconus and Down Syndrome

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Purpose: To describe the clinical outcome of corneal cross-linking (CXL) in a young child with keratoconus.

Methods: This is a case report of a young girl with keratoconus with ophthalmologic findings and 3-year follow-up. Follow-up visits included visual acuity measurement, retinoscopy, corneal tomography, and topography.

Results: A girl with Down syndrome was diagnosed with bilateral keratoconus and relative amblyopia at the age of 4 years. The best-corrected near visual acuity was 20/100 binocularly. Corneal tomography showed the following parameters: OD K_{max} 47.2 diopters (D), thinnest location 442 μm; OS K_{max} 49.6 D, thinnest location 432 μm. Three months later, the keratoconus in the left eye progressed (K_{max} 50.2 D, thinnest location 424 μm), and CXL was performed. One year later, CXL was necessary also in the right eye because of progression. The girl was most recently reexamined at the age of 7 years. The corrected near visual acuity was 20/80 in both eyes. The corneal curvature slightly flattened, and the corneal thickness stabilized (OD K_{max} 46.8 D, thinnest location 389 μm; OS K_{max} 49.4 D, thinnest location 360 μm).

Conclusions: Onset of keratoconus can occur in early childhood, especially in patients with Down syndrome. In this case, CXL was performed at 4 and 5 years of age without complications and stopped further keratoconus progression.

Key Words: cross-linking, cornea, keratoconus, childhood, Down syndrome

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Keratoconus is a noninflammatory corneal dystrophy characterized by changes in the collagen structure and organization. Reduced collagen cross-linking and increased pepsin digestion are probably responsible for the structural weakness of the cornea, which in the case of keratoconus has a stiffness of only 60% of the normal cornea.[1] The reduced mechanical stability of the cornea leads to ectasia with impaired vision caused by irregular astigmatism, progressive myopia, corneal thinning, and occasionally corneal scarring. Corneal cross-linking (CXL) with riboflavin and UV-A irradiation has been established as an effective treatment option. CXL has been demonstrated to stop the progression of keratoconus in both adults and children, possibly avoiding the need for keratoplasty.[2–4] Especially in children, keratoconus is often more advanced at the time of diagnosis than in adults and progresses more rapidly.[5] We report the case of a girl with Down syndrome, who was diagnosed with bilateral keratoconus and secondary amblyopia at the age of 4 years. Because of documented progression, a decision to perform CXL in early childhood was made.

CASE REPORT

A 4-year-old girl with Down syndrome had been referred by an attentive ophthalmologist for the assessment of astigmatism and suspiciously distorted light reflexes in retinoscopy in both eyes. At the first presentation, cycloplegic retinoscopy showed a refractive error of −0.5/−1.75/93° for the right eye and +3.0/−3.0/98° for the left eye. The best-corrected near visual acuity was 20/100 binocularly. Slit-lamp examination showed bilateral central thinning of the cornea and Vogt striae in the paracentral area. Corneal tomographies and topographies with the Oculus Pentacam (Oculus, Wetzlar, Germany) and Tomey TMS 4 (Tomey, Erlangen, Germany) were performed. Tomography showed a maximal curvature (K_{max}) of 47.2 diopters (D), with a thinnest corneal thickness (TCT) of 442 μm in the right eye and a K_{max} of 49.6 D and TCT of 432 μm in the left eye.

Topography could not be performed initially in the right eye because of the lack of cooperation. In the left eye, measurements revealed a keratometry of 46.1 D at 162 degrees in the steep meridian (K_s), 43.1 D at 72 degrees in the flat meridian (K_f), and an average corneal power (AveK) of 44.6 D. Bilateral keratoconus was diagnosed, being more pronounced in the left eye. A possible treatment with CXL in the case of further progression was discussed with the parents.

The follow-up examination after 3 months revealed progression of keratoconus in the left eye (K_{max} 50.2 D, TCT 424 μm; TMS K_s: 48.0 D at 169 degrees, K_f: 46.7 D at 79 degrees, AveK 47.3 D), shortly thereafter, epi-off CXL was performed under general anesthesia using a standard Dresden protocol.[6] Intraoperative pachymetry was performed using a Tomey SP-100 ultrasound pachymeter (Tomey), showing corneal thinning to 290 μm. Corneal swelling was induced with hypoosmolar riboflavin. Repeated intraoperative pachymetry revealed a thickness of 400 μm. The eye was irradiated for 30 minutes with UV-A (3 mW/cm^2, UV-X-1000; IROC Innocross, Zug, Switzerland).

A year later, CXL was also performed in the right eye because of progressive thinning and increasing curvature of the cornea

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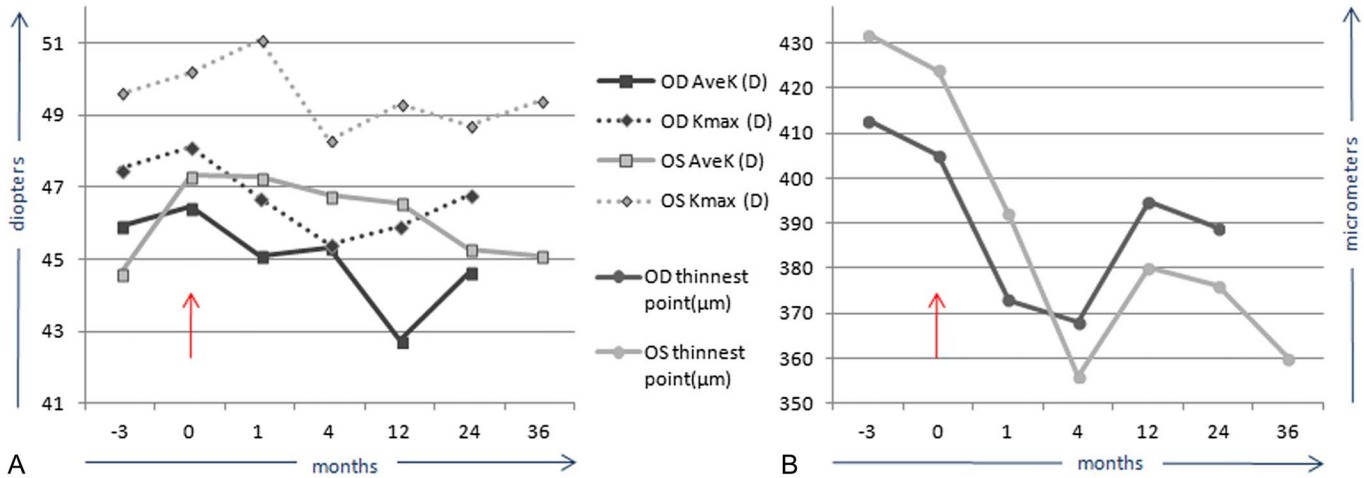

FIGURE 1. Anterior corneal curvature (K_{max} and AveK, A) and corneal thickness (thinnest point, B) before and after CXL. The arrows show the time of CXL.

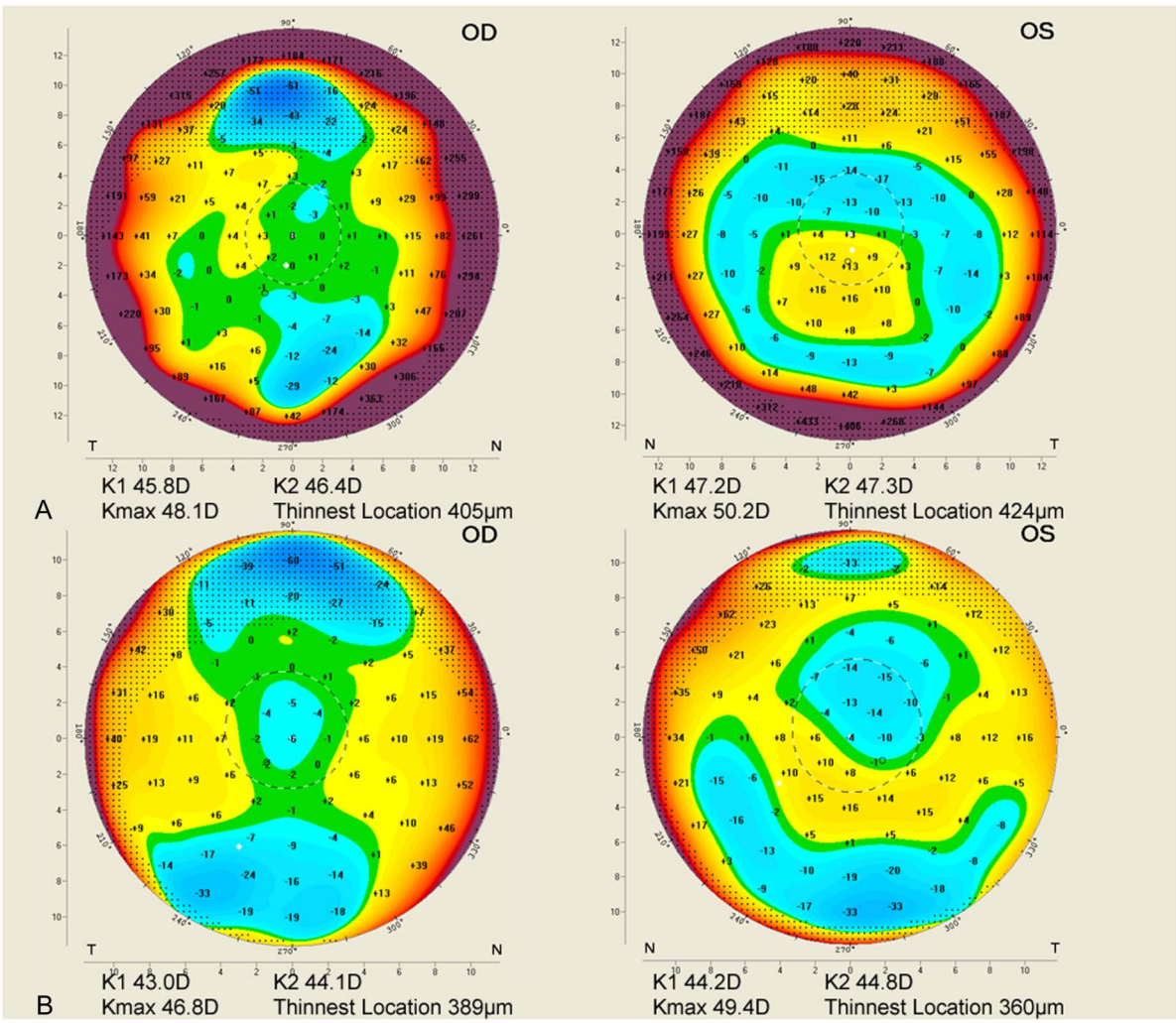

FIGURE 2. Preoperative (A) and postoperative (B) topographies (elevation, front) using the Pentacam (24-month follow-up in the right eye and 36-month follow-up in the left eye).

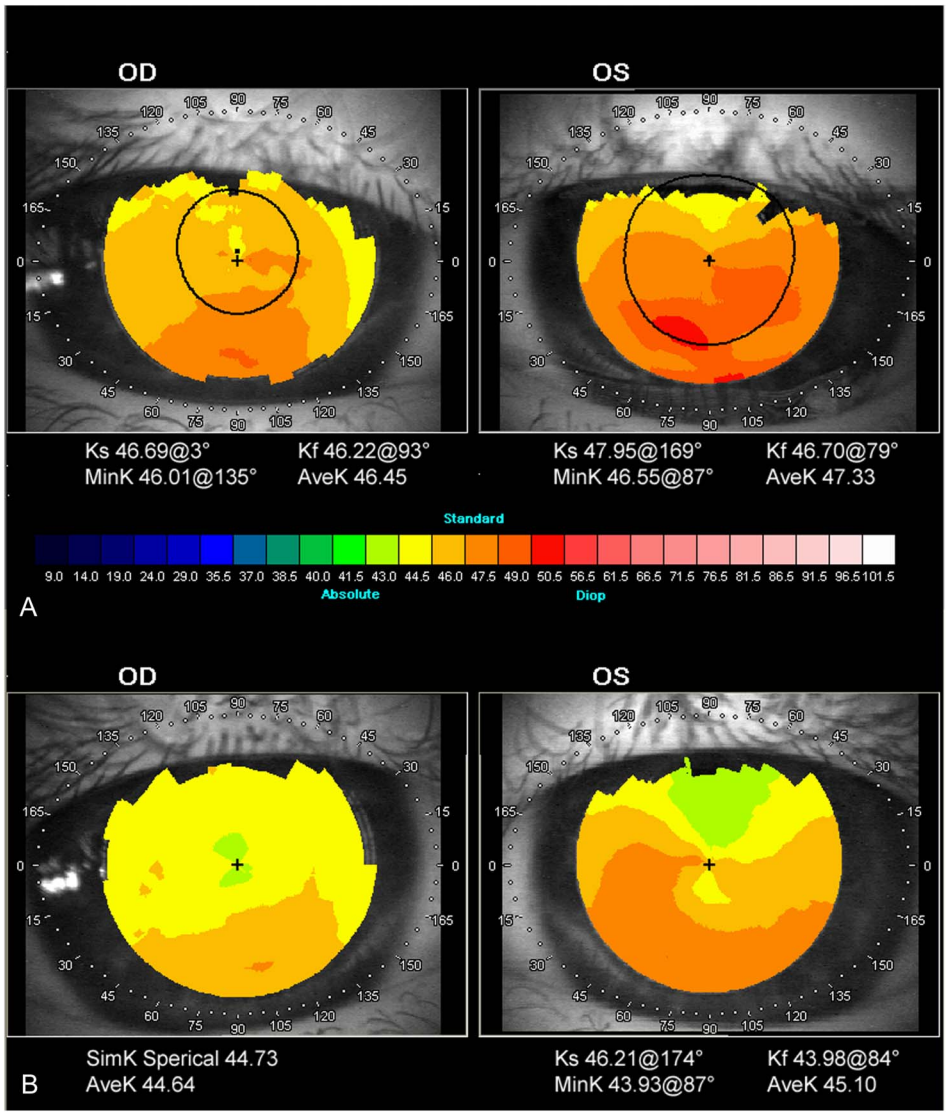

FIGURE 3. Preoperative (A) and postoperative (B) topographies using TMS (24-month follow-up in the right eye and 36-month follow-up in the left eye).

(Pentacam K_{max} 48.1 D, TCT 405 μm; TMS K_s: 46.7 D at 3 degrees, K_f: 46.2 D at 93 degrees, AveK 46.4 D). Intraoperative stromal swelling with hypoosmolar 0.1% riboflavin was also needed for this eye: the cornea had thinned to 388 μm and was swelled to 444 μm before irradiation. No complications occurred during or after both surgeries. The postoperative local treatment consisted of ofloxacin 5 times daily (Floxal UD; Bausch & Lomb, Zug, Switzerland) until complete epithelialization and fluorometholone 4 times daily (FML Liquifilm; Allergan, Pfaeffikon, Switzerland) during 1 month.

Topographic and tomographic measurements at the last follow-up (ie, 2 years for the right eye and 3 years for the left eye) are shown in Figures 1–3. A marked bilateral flattening effect was observed within the first postoperative year. Topographies stabilized over the next 2 years in the left eye, whereas slight progression was observed during the second year of follow-up in the right eye, but the values were still flatter compared with preoperative measurements (Fig. 1A). The corneal thickness remained stable after initial thinning (Fig. 1B). Overall, K_{max} decreased from 48.1 D to 46.8 D in the right eye and from 50.2 D to 49.4 D in the left eye (Figs. 1A, 2A, 2B). AveK decreased from 46.4 D to 44.6 D in the right eye and from 47.3 D to 45.1 D in the left eye (Figs. 1A, 3A, 3B). Stabilization of keratoconus was achieved in both eyes. The last cycloplegic retinoscopy showed a refractive error of +2.5 in the right eye and +5/−1.5/90° in the left eye. The best-corrected near visual acuity was 20/80 in both eyes.

DISCUSSION

We report the outcome of CXL in a 4-year-old child with progressive keratoconus with a follow-up of 3 years. This case demonstrates that keratoconus can be diagnosed at a very young age. To our knowledge, this patient is one of the youngest ever described. It may be speculated that Down syndrome is a risk factor for the early onset of the disease; and eye rubbing was never noted during visits or reported by the parents. In our clinical experience, fast progression of keratoconus as in this child is not untypical in very young children. Hence, an early diagnosis and recognition of progression are even more important.

In our case, further keratoconus progression was arrested and visual acuity was stabilized after CXL. As described for older patients with keratoconus in previous studies, the initial deterioration of all keratoconus indices, probably induced by the epithelial debridement, was followed by a continuous improvement of most of the indices during the observed period.[3] The marked corneal thinning after CXL has also been described.[3]

Although transepithelial CXL might have some advantages particularly in regard to complications and comfort,[7] we decided to perform epi-off CXL because of better evidence for its efficacy.[8] Discussion about transepithelial CXL is ongoing, especially because of the reduced penetration of riboflavin through the intact epithelium and partial blockage of UV-A light from reaching the stroma.[9] In an animal model, Wollensak and Iomdina[10] revealed that corneal CXL without epithelial debridement reduced the biomechanical effect by approximately one-fifth compared with standard epi-off CXL. CXL is a very safe procedure when performed correctly, that is, under sterile conditions and with postoperative topical antibiotics. The risk for infectious keratitis is very low, probably because of the fact that the treated patients are young and without corneal surface problems, so that reepithelialization is fast. When performing CXL in very young children, such as in our case, the additional risks of general anesthesia have to be taken into account.

Consistent topographic and tomographic measurements can be challenging in young children, especially in those with Down syndrome, because of poor fixation and lack of concentration. In our case, good measurements were obtained thanks to a very cooperative and quiet girl, helpful parents, and very experienced technicians. In our experience, repeated measurements with several machines and on different days may be necessary to diagnose and follow keratoconus in young children.

Our case shows that standard epi-off CXL may be safe and effective in arresting keratoconus progression in early childhood.

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