

Corneal Collagen Cross-Linking in Children

Extra care is required in pediatric patients with progressive keratoconus.

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Keratoconus is a slowly progressive, noninflammatory corneal thinning disorder characterized by changes in the structure and organization of corneal collagen. The ectasia progresses at a variable rate and may be more rapid in pediatric patients with vernal keratoconjunctivitis (VKC). Many times, these patients present with acute hydrops.¹ Because of the patients' young age, keratoconus often has a significantly negative effect on their quality of life. Corneal collagen cross-linking (CXL; not approved for use in the United States) is an established technique used to halt the progression of keratoconus. Complications with this modality are rare.²

CLINICAL DATA

We conducted a retrospective review of a series of 25 eyes of 15 children aged 9 to 16 years with progressive keratoconus who underwent CXL.³ Six (40%) children had VKC-associated keratoconus. Mean follow-up was 24.57 months (range, 1-3 years).

In most patients, our results were encouraging. Mean preoperative keratometry (K) was reduced from 51.96 ± 5.75 D preoperatively to 48.73 ± 3.83 D postoperatively (Figure 1). An improvement in BCVA by 1 line or more was noted in all (100%) eyes at the last follow-up. Mean aberration coefficient was reduced from 2.6 ± 0.96 preoperatively to 2.42 ± 0.92 postoperatively (Figure 2).

No complications were noted in the series, except for mild haze and minimal scarring postoperatively that had no effect on BCVA. The study results showed stabilization and improvement in keratoconus in terms of BCVA and corneal curvature after CXL. We concluded that CXL with riboflavin is a safe and effective procedure in children with progressive keratoconus.

There have been isolated reports of side effects after CXL such as diffuse lamellar keratitis, herpetic keratitis

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with iritis, development of corneal haze, corneal melting, and sterile keratitis.⁴⁻¹⁰ Children with keratoconus are frequent eye rubbers, especially the subgroup of children with coexisting VKC. There is usually associated ongoing surface inflammation, papillary reaction, and sometimes meibomian gland dysfunction as well. There could also be signs of partial limbal stem cell deficiency in children with VKC. Enhanced cell-mediated immunity is said to play a role in the development of sterile keratitis.⁴

We must be extremely cautious before subjecting such eyes to CXL. Preoperatively, the eye should be quiet with no signs of VKC-related surface inflammation. Steroids and antiallergy eye drops may be needed to quiet the eye completely before scheduling the procedure. Rigorous lid hygiene and application of antibiotic ointment should be advised at least 2 to 3 weeks in advance in children with coexisting meibomian gland dysfunction to prevent any episodes of sterile or infectious keratitis postoperatively. A silicone-hydrogel bandage contact lens should be applied at the conclusion of the procedure and should be kept on the eye for no more than 3 to 4 days postoperatively. Children should be seen for follow-up on a daily basis after CXL until the epithelium heals and the bandage is removed. Postoperative antibiotic-steroid combination, lubricants, and nonsteroidal antiinflammatory drops should

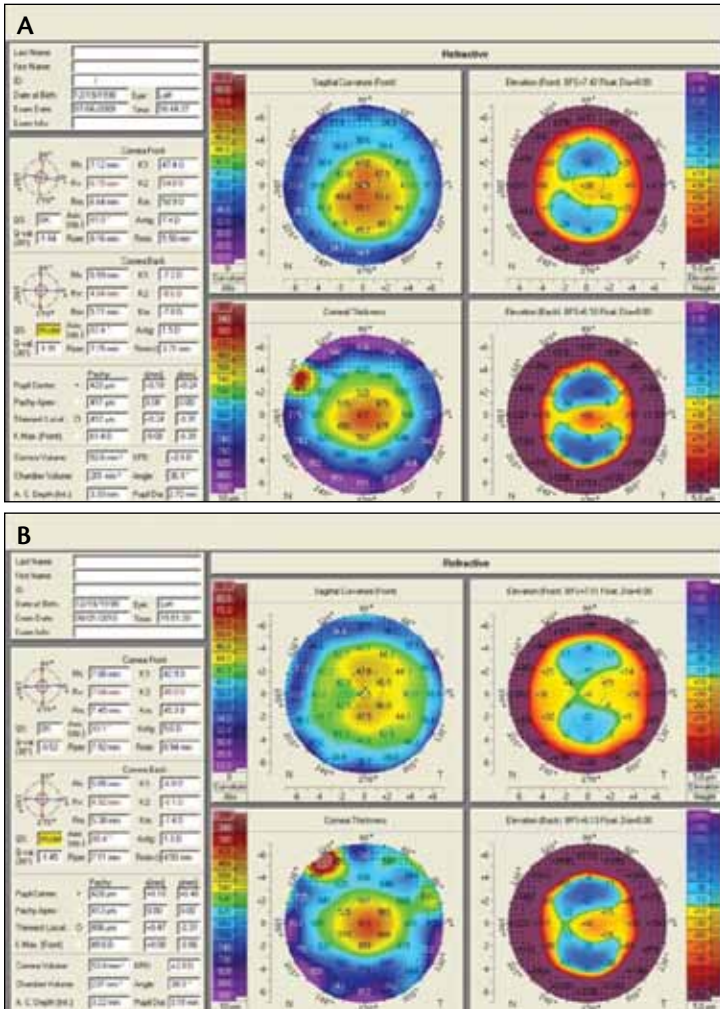


Figure 1. Before CXL (A), K1 was 47.40 D, K2 was 54.80 D, and the thinnest pachymetry reading was 412 μm . One year after CXL, K1 was 42.90 D, K2 was 48.00 D, and the thinnest pachymetry reading was 406 μm (B).

be administered for 3 to 4 weeks. Following this regimen, we did not observe a single case of keratitis after CXL.

Limbal stem cell deficiency after CXL, especially in the pediatric age group, is another potential concern. The limbal region, where the corneal epithelium joins the conjunctival epithelium, contains a radial arrangement of trabecular conjunctival processes known as *the palisades of Vogt*. These are thought to be the site of origin of corneal stem cells. In CXL, irradiation of the limbal region should be carefully avoided to protect this proliferative component of the cornea.

Limbal protection is possible if the peripheral epithelium is left in situ beyond a central scraped area, 9 mm in diameter, and if the whole corneal surface is covered in riboflavin 0.1% solution 10 minutes before and during the treatment. The epithelial ring beyond 9 mm, associated with the riboflavin solution, provides protection by absorbing 95% of the ultraviolet A (UVA) energy in a cornea at least 400 μm thick. Lateral diffusion of UVA irradiation during CXL has been found to be less than 20 μm .^{11,12} The possibility of direct visual control of the UVA spot by the microcamera available in the Vega (Ofta high-tech Innovazione Tecnico Chirurgica; not available in the United States) UVA light source is a good method to ensure patient fixation and avoid tilting and defocusing of radiation on the limbus. The use of polymethyl methacrylate rings of different diameters ensures absolute limbal

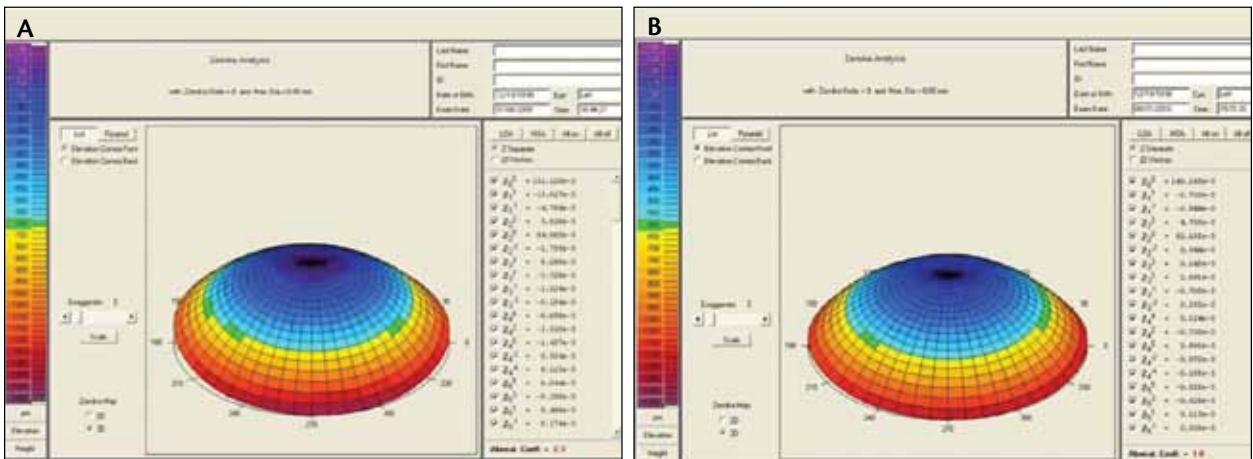


Figure 2. Before CXL, the aberration coefficient was 2.3 (A); postoperatively, the aberration coefficient was 1.8 (B).

TAKE-HOME MESSAGE

- CXL can be considered a safe and effective procedure in the pediatric population with progressive keratoconus, although extra care must be taken in this subgroup of patients.
- Parents should be well informed about CXL and the possibility that repeat treatment may be required.

protection in low-compliance patients who do not maintain adequate fixation.¹³

The ongoing surface inflammation in patients with VKC creates a state of partial limbal stem cell deficiency that can be further aggravated by CXL. Therefore, it is necessary to adequately protect the limbal region by avoiding irradiation and maintaining proper fixation, especially in this subgroup of patients with keratoconus.

Preoperative and postoperative limbal scans by confocal laser scanning microscopy of the palisades of Vogt and the corneal epithelium have shown no loss of limbal germinal structures after CXL. With 3-year follow-up, stability of the limbal architecture was seen.¹³

REPORTS IN THE LITERATURE

There are few published reports on the results of CXL in pediatric patients. Reeves et al¹⁴ conducted a multivariate analysis showing that patients aged 30 years or younger had a sevenfold increased risk of transplantation compared with patients older than 40 years of age. The researchers suggested that pediatric age at the time of diagnosis represents a negative prognostic factor for keratoconus progression, with increased probability of corneal transplant.

According to international results,¹⁵⁻¹⁷ cross-linking should be the primary choice in young patients with progressive keratoconus. The Siena CXL Paediatrics pilot study demonstrated the ability of CXL to retard keratoconus progression in all age groups, with better functional response in patients younger than 26 years. Treatment ensured long-term keratoconus stabilization in more than 90% of treated cases.

Caporossi et al¹⁸ evaluated the stability and functional response after riboflavin UVA-induced CXL in a population of patients younger than 18 years with progressive keratoconus after 36 months of follow-up. The study demonstrated significant and rapid functional improvement along with stability of keratoconus in this age group.

CONCLUSION

CXL can be considered a safe and effective procedure in the pediatric population with progressive keratoconus. Extra care is needed in this subgroup of patients, as children are more prone to infections and a heightened allergic response. Parents should be well informed about CXL and the possibility that repeat treatment may be required. ■

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