Bilateral Keratoconus and Corneal Hydrops Associated with Eye Rubbing in a 7-year-old Girl

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Purpose: To report a young child with bilateral keratoconus in the context of vernal keratoconjunctivitis (VKC) who developed bilateral corneal hydrops associated with eye rubbing, and to discuss the pathogenesis and review the pertinent literature.

Case Report: A seven-year-old girl with VKC and asymmetric keratoconus developed corneal hydrops due to habitual eye rubbing. Corneal edema subsided within 16 weeks in her right eye and 9 weeks in the left eye with subsequent corneal scarring.

Conclusion: Continuous mechanical trauma, such as eye rubbing, plays a significant role in the pathogenesis of keratoconus and subsequent hydrops even in childhood.

Keywords: Juvenile Keratoconus; Corneal Hydrops; Children; Eye Rubbing

INTRODUCTION
Keratoconus (KCN) is a bilateral, non-inflammatory, progressive ectatic disorder of the cornea. The incidence of KCN is about 1 per 2,000 in the general population. Classically, the onset of KCN is during puberty and the condition is progressive until the third or fourth decades of life. KCN may be associated with corneal hydrops due to rupture of the endothelium and Descemet membrane, permitting aqueous to enter the stroma. Corneal hydrops occurs in approximately 3% of eyes with KCN. Few cases of KCN attributed to eye rubbing have been reported. Herein, we present a seven-year-old girl with KCN attributed to eye rubbing associated with vernal keratoconjunctivitis (VKC) with severe corneal hydrops leading to marked visual impairment and corneal scarring.

CASE REPORT
A 7-year-old girl presented with ocular pain, redness, photophobia and suddenly decreased vision in both eyes for 3 days. Medical history was negative except for a history of VKC for 3 years treated with occasional cromolyn sodium eye drops. There was no history of contact lens or spectacle use. Family history was unremarkable. According to the parents, the child habitually rubbed both of her eyes vigorously even during sleep.

Visual acuity was 20/400 in the right eye and 20/200 in the left eye. Retinoscopy was not possible due to poor red reflex. Slit lamp examination revealed pseudogerontoxon in both eyes, severe hydrops, stromal edema and bullae formation in the entire right cornea only sparing a small superior area, and the inferior part of the left cornea (Figure 1).
Topical fluorometholone and cromolyn sodium drops were initiated every 6 hours. The hydrops subsided within 16 weeks in the right eye and 9 weeks in the left eye with subsequent corneal scar formation. With reduced corneal haze, ruptured Descemet membrane was visible (Figure 2).

Computed corneal topography was performed at this stage which revealed significant corneal flattening in both eyes corresponding to corneal scar formation (Figure 3). Final best corrected visual acuity was 20/80 in the right eye and 20/100 in the left eye.

DISCUSSION

Despite many theories regarding the etiology of KCN, its exact cause remains unknown. In some cases, KCN appears to be inherited, and in others, it is associated with systemic conditions such as vernal keratoconjunctivitis, atopic disease, contact lens wear, Down syndrome, Marfan syndrome, connective tissue disease, and mitral valve prolapse. KCN not only demonstrates an increased incidence at puberty, but also shows faster progression at puberty and pregnancy due to hormonal influences.

Mechanical trauma and eye rubbing has been recognized as a risk factor for KCN since 1956 by Ridley. In a large longitudinal study, Zadnik et al found that almost half of keratoconic patients reported severe eye rubbing. In uncontrolled studies on keratoconic patients, the prevalence of eye rubbing has ranged from 66 to 73 percent. There are also some reports regarding the association between acute hydrops and vigorous eye rubbing. Additionally, it has been hypothesized that the cone is typically

Figures 1. The right and left eyes (top and bottom images, respectively) of the child with bilateral keratoconus and hydrops. Note severe hydrops with stromal edema and bullae formation.

Figure 2. Right and left eyes (top and bottom images, respectively) of the same subject as in figure 1 after complete resolution of corneal edema 16 and 9 weeks after hydrops; note the scar formation.
Eye rubbing is also one feature of a number of conditions linked to keratoconus such as Down syndrome, atopic keratoconjunctivitis, mental retardation, and Leber’s congenital amaurosis.\textsuperscript{1}

Zadnik et al found an association between patient-reported unilateral eye rubbing and asymmetry of corneal curvature. The rubbed cornea was frequently steeper.\textsuperscript{18}

Several case reports link severe eye rubbing to the development of acute hydrops.

In a series of 21 patients (22 eyes) with acute hydrops including 19 eyes with KCN, two eyes with pellucid marginal degeneration, and one eye with keratoglobus, Grewal et al reported that 21 eyes had seasonal allergy and 20 eyes had allergy-associated eye rubbing behavior. Additionally, 14 eyes had an association of opposite dominant hand and affected eye. This association suggests more traumatic eye rubbing across the face.

In one report, mean age at the onset of corneal hydrops was 39.3 (range 12-66) years.\textsuperscript{14} In another study by Tuft et al, mean age at the onset of hydrops was 24 years.\textsuperscript{19} Ozcan et al reported a case of severe acute corneal hydrops in an 11-year-old boy with KCN associated with Down syndrome and vigorous eye rubbing.\textsuperscript{20} In another report, Jafri et al described five patients with KCN attributed to eye rubbing, amongst which the youngest patient was a 13-year-old girl.\textsuperscript{6}

The exact mechanism by which eye rubbing may cause keratoconus is unknown. It has been proposed that interleukin-1 (IL-1) plays a major role in the pathogenesis of keratoconus. Studies have shown that keratocytes from keratoconic corneas have a four-fold greater number of IL-1 receptors than normal corneas. The increased expression of IL-1 receptor sensitizes the keratocytes to IL-1 which is released from the epithelium or endothelium during eye rubbing and epithelial microtrauma. This results in loss of keratocytes through apoptosis and a decrease in stromal thickness over time.\textsuperscript{1}

Acute hydrops is significant corneal stromal and epithelial edema secondary to rupture of Descemet’s membrane. Although most commonly associated with keratoconus,
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it has also been reported with keratoglobus, Fuchs’ superficial marginal keratitis, pellucid marginal degeneration and Terrien’s marginal degeneration.\textsuperscript{14, 21-24}

The stromal edema is typically self-limited and resolves in 6 to 10 weeks.\textsuperscript{2} Endothelial cells cover the exposed stroma and form a thin layer of Descemet membrane. However, intracameral injection of air, perfluoropropane ($C_3F_8$), and SF\textsubscript{6} have been reported as therapeutic options.\textsuperscript{25,26} Surgical procedures are also occasionally necessary in cases with significant scar formation or persistent stromal edema. The resultant corneal scarring with flattening of the conical corneal deformation leading to improvement of visual acuity has been documented in several studies.\textsuperscript{14,19}

Keratoconus and in particular hydrops is rare in childhood. Ioannidis et al reported a 7-year-old girl with unilateral keratoconus secondary to eye rubbing.\textsuperscript{27} However, we were unable to find any report of keratoconus and hydrops in children under 10 years of age. Although acute hydrops was severe in our patient, complete resolution of corneal edema occurred after 16 and 9 weeks in the right and left eyes, respectively. Finally, she developed a central corneal scar with subsequent flattening secondary to corneal hydrops. Visual acuity improved due to the decrease in corneal steeping after scar formation.

In summary, eye rubbing in VKC may be a contributing factor in the development of KCN and corneal hydrops even in prepubescent children. Medical therapy and observation can be effective management, even in the presence of severe corneal edema.

Conflicts of Interest
None.

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