

Section on Cornea and Contact Lenses
Information for Eyecare Practitioners
KERATOCONUS

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Keratoconus (KC) is a bilateral, asymmetric, corneal disorder that results in progressive thinning, steepening, irregular astigmatism, and potentially scarring.¹ Several characteristic signs and symptoms are observed that become more prevalent as KC progresses. Patients may first begin to observe decreased best corrected spectacle vision and, upon examination, they will likely have increased regular and irregular corneal astigmatism and one or more of the following clinical signs: corneal distortion as measured by keratometry, topography, or the red reflex; an inferiorly thinned and displaced apex of the cornea; isolated corneal steepening measured by topography; deposition of iron in a ring or ring segment in the corneal epithelium surrounding the base of the cone (Fleisher's ring); Vogt's striae in the posterior corneal stroma; and central corneal scarring. Keratoconus is bilateral in approximately 96% of the cases.^{2,3} Typically one eye is diagnosed earlier and progresses more than the fellow eye.^{4,5} There does not appear to be a significant difference in the incidence of keratoconus between left and right eyes nor between males and females.⁶

Causes

The cause of KC is unknown, although metabolic/chemical changes in the corneal tissue have been documented.⁷⁻³⁷ However, the disease has been associated with atopy,^{6,38-54} connective tissue disorders,^{1,55-66} eye rubbing,^{1,38,42,46,48,49,57,67-92} contact lens wear,⁹³⁻⁹⁷ and inheritance.^{1,97-121,14,19,54,102,103,105-107,110,122-161} Between 6%-18% of patients with keratoconus have a history of familial disease.^{6,16,90,100,114,162,163} In fact, several studies suggest that KC is a complex genetic disease.¹⁶⁴⁻¹⁶⁶

Incidence and Prevalence

The prevalence of KC is stated to be 1/2000 persons. With 270 million Americans this translates to 135,000 Americans with the diagnosis of KC.^{3,6} However, the only estimate of the incidence and prevalence of KC comes from a study conducted in Olmsted County in Minnesota, which identified 64 incident cases of KC between 1935 through 1982 at the Mayo Clinic.¹⁶⁷ Case ascertainment was based solely on medical record review with the diagnosis determined by the "examiner's description of characteristic irregular light reflexes observed during ophthalmoscopy or retinoscopy or irregular mires detected at keratometry". Kennedy et. al (167) estimated the overall average annual incidence rate at two per 100,000 population with a prevalence of 55 per 100,000. These estimates are improbably low given current diagnostic techniques. Other groups have reported the incidence as high as 25 per 100,000 in populations that have traditions of consanguineous marriages.^{49,102,168-174} The higher incidence was suggestive of a genetic factor being significant in the etiology.

The Collaborative Longitudinal Evaluation of Keratoconus (CLEK) Study was the largest multicenter, prospective, observational study designed to describe the course of keratoconus and the associations among its visual and physiological manifestations. The CLEK Study characterized the course of keratoconus and identified factors related to vision, progression, and corneal scarring in keratoconus. A total of 1,209 patients were enrolled between May 31, 1995, and June 29, 1996, at 15 participating clinics, and patients were re-

examined annually for eight years, through mid 2004. The results of the CLEK Study will be referenced throughout this paper.

Progression

Patients first diagnosed with keratoconus want to know the prognosis for progression and loss of vision. Clinicians would like to be able to predict the rate of progression and to identify those patients who will advance to severe keratoconus. However, the rate of progression for a particular patient is impossible to predict. Some patients advance rapidly for six months to a year and then stop progressing, with no further change. Often there are periods of several months with significant changes followed by months or years of no change; this may then be followed by another period of rapid change. In the CLEK Study, the slope of the change of flat K was approximately 0.20 D diopters per year; over seven years; this translated into an expected steepening of 1.44 D. Steepening of 3 D or more in either eye had an incidence of 23%.¹⁷⁵

Contact Lens Correction

The mainstay of optical correction for patients with keratoconus is the wearing of rigid gas permeable (RGP) contact lenses because of the ability of RGP contact lenses to mask irregular astigmatism by creating a new, smooth optical refracting surface. Almost 90% of the keratoconic patients in the recent CLEK Study were wearing rigid contact lenses when they were enrolled. Other corrective options are spectacles or soft contact lenses, used primarily during the early or mild stages of the condition or when the area of the cornea over the pupil is relatively free of distortion.

In the United States (US) most rigid lens wearers with keratoconus are fitted “flat” This means the back surface of the contact lens comes into contact with the apex of the cone, applying varying degrees of pressure there. Whether lenses should be fitted this way in eyes with keratoconus is a matter of controversy at the present.^{6, 176, 177}

Quality of Life

A relatively new and powerful means to determine the effect a disease has upon an affected individual is to measure the quality of their life.¹⁷⁸⁻¹⁸⁵ The CLEK Study measured this through the course of the 8 year study. The National Eye Institute (a branch of the National Institutes of Health) developed a vision specific quality of life instrument to assess how different eye diseases affect their victims. This instrument is called the NEI VFQ.^{92, 186-192} In people with keratoconus, NEI VFQ scores were quite low indicating that keratoconus has a profound effect.¹⁸⁴ In particular, pain scores were notably troublesome, even when compared to non-diseased rigid gas permeable lens wearers.^{184, 193}

Surgical Correction

KC is the most common corneal thinning disorder, which as a group, comprise the second most common indication for corneal transplantation in the United States, totaling nearly 16% of all cases in 2006.¹⁹⁴ In 2006, KC accounted for 15.9% of the 33,962 keratoplasties performed in the United States. When surgery is indicated, a penetrating

keratoplasty (PKP) is the primary procedure performed reported at rates varying between 12% to over 60% depending on the cohort studied.¹⁹⁵⁻¹⁹⁸

In the CLEK Study, 9.8% of patients at baseline had a PKP in one eye, and, during the course of the 8-year study, 12% of those patients who started the study free of a PKP in either eye proceeded to a PKP in one or both eyes.¹⁸⁰ After PKP, patients are still subject to a risk of graft rejection or other complications (e.g., infection, high postoperative astigmatism, wound dehiscence post blunt trauma). Different forms of rejection appear dependent on the layer of the donor cornea being rejected: epithelium, stroma or endothelium. The body gradually replaces donor epithelium with recipient epithelium, therefore this type of rejection would occur only in the earlier (first year) post-operative period. Isolated stromal rejection can uncommonly occur; when it does it appears as stromal infiltrates and neovascularization. The most common form of rejection is endothelial where keratic precipitates may be scattered across the endothelium or in linear form advancing in from the peripheral cornea (Khodadoust line). Once the endothelium is damaged, edema of the stromal and epithelial layers can occur and is a very prominent sign. Even though full thickness corneal transplantation has a lifetime risk of endothelial and stromal rejection, PKP for KC has the lowest risk of long term graft failure compared to other conditions requiring corneal transplantation. The cornea is actually a “privileged site” and somewhat less susceptible to rejection than solid organ transplants.

Other available procedures such as deep anterior lamellar keratoplasty (DALK) and intrastromal ring segments (INTACS) avoid PKP, but they are not as common and their long-term success is not known. In the DALK procedure the posterior limiting membrane (Descemet’s membrane) of the cornea and endothelial layer remain which eliminates the risk of endothelial rejection; however, it is a more difficult procedure to perform and the graft is still subject to stromal and early phase epithelial rejection. Additionally, DALK and PKP are still at risk for immune mediated sub-epithelial infiltration which can appear as a distinct form of rejection. The INTACS (intracorneal rings) procedure is limited to early cases of the disease and patients still have to use contact lenses post-operatively to achieve their best visual potential. This procedure involves implanting rigid plastic ring segments into the mid-peripheral corneal stroma. The thickness of the ring segments leads to some flattening and smoothing of the central cornea. The INTACS procedure has been approved by the Food and Drug Administration (FDA) on a “compassionate use” basis. Several series have reported an improvement in visual acuity, corneal curvature and contact lens tolerance up to 36 months post implantation.^{160, 199-201} The authors of this position paper cannot independently confirm the improved contact lens tolerance. We find it difficult to fit patients with contact lenses after INTACS and have not been impressed with improved lens tolerance.

Conclusions

Keratoconus is an uncommon non-inflammatory corneal thinning disorder that commonly results in some degree of visual impairment. In mild or early stages of the condition spectacles, soft lenses and gas permeable lenses may provide adequate vision to the affected individual. As the disease worsens, gas permeable corneal lenses are most often called for to correct visual deficits. A minority of patients ultimately necessitate corneal replacement surgery. This disease has a profound effect on patients, commonly resulting in significant difficulties conducting the affairs of life.

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