Contact Lens Update
CLINICAL INSIGHTS BASED IN CURRENT RESEARCH

Corneal Ectatic Diseases - A Review of the Latest Treatments, Including Therapeutic Contact Lenses and Surgery

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Introduction

Ectatic corneal disease (ECD) comprises a group of disorders characterized by progressive thinning and protrusion of the cornea, leading to visual impairment.[1] The most prevalent form of ECD is keratoconus (KC),[2] which affects individuals of all ethnicities and genders with one eye usually more severely affected than the other.[3-7] To ensure successful management of ECDs, a thorough understanding of their underlying causes and up-to date knowledge of advancements in treatment methods is crucial. Implementing effective management strategies is essential for enhancing visual outcomes and improving the quality of life for affected patients.

Differentiating Corneal Ectasias

The Global Consensus on Keratoconus and Ectatic Diseases study addressed several key aspects of ECDs.[8] The study investigated primary ectatic diseases and their relationship to secondary ectasias. It established that primary ECDs include KC, pellucid marginal degeneration (PMD), keratoglobus, and post-refractive surgery progressive ectasia, as they are characterized by intrinsic structural abnormalities in the cornea. Secondary ectasias, on the other hand, refer to corneal shape changes caused by external factors, such as corneal surgery or trauma, with no underlying ectatic propensity existing, and would be considered “thinning disorders” as opposed to a primary ECD. The study emphasized the importance of distinguishing between primary and secondary ectasias in diagnosis and management, as their underlying mechanisms and treatment approaches may differ.

It also highlighted the differences between KC, PMD and keratoglobus.[8] PMD is characterized by thinning and steepening of the inferior peripheral cornea, creating a characteristic “crab claw” or “kissing doves” pattern, while KC involves localized thinning and cone-shaped protrusion in the central cornea (Figure 1). PMD typically affects individuals in their fourth or fifth decade of life, while KC usually manifests during puberty.

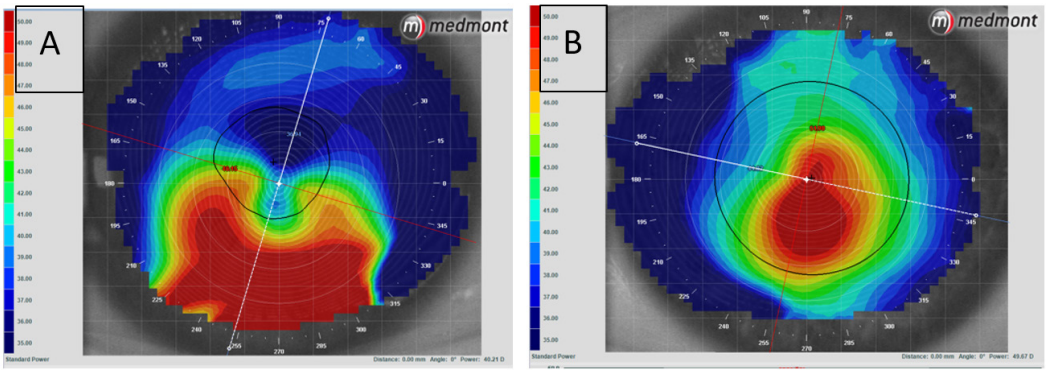

Figure 1: (A) Demonstrates the characteristic pattern of pellucid marginal degeneration, while (B) exhibits keratoconus.

The experts also clarified that keratoglobus and KC are different clinical entities.[8] They highlighted that keratoglobus is a rare condition characterized by generalized corneal thinning and spherical protrusion. Keratoglobus is typically present at birth or develops in early childhood, and its progression is usually slower and more stable compared to KC. The study emphasizes the importance of accurate diagnosis and differentiation between these conditions to guide appropriate management strategies for optimal patient outcomes.

Understanding Inflammation in Keratoconus

Recent research suggests that KC may involve ocular inflammation,[9-13] contrary to previous beliefs.[1,14] McMonnies explored the role of inflammation in the development and progression of KC and discussed its implications for management.[15] While KC is influenced by genetic and environmental factors, McMonnies emphasized inflammation as a significant contributor to its pathogenesis. Factors like eye rubbing, atopy, and contact lens wear can trigger inflammation, leading to the release of chemical mediators and activation of immune cells. Chronic inflammation may contribute to disease progression and complications. Understanding inflammation's role has important implications for KC management, with anti-inflammatory treatments potentially aiding in disease control. However, further research is needed to establish precise mechanisms and assess the efficacy of specific anti-inflammatory interventions.

Revisiting Keratoconus Characteristics and Its Classification

The Global Consensus on Keratoconus and Ectatic Diseases paper disputed the existence of true unilateral KC and stresses the importance of evaluating both eyes thoroughly.[8] Even the seemingly unaffected eye may display subtle signs of the disease. Individualized management approaches are necessary based on the severity and progression in each eye.

The global experts also agreed that there is currently no clinically adequate classification system for KC.[8] Standardization and comprehensive consideration of clinical and topographic parameters are necessary. A new classification system incorporating clinical signs, topographic patterns, and progression criteria could improve diagnosis, monitoring, and treatment planning for patients with KC.

Individualized Management Approaches

The management of ECDs involves various optical and surgical options. Spectacles are typically recommended for mild cases. In recent years, there have been significant advancements in the field of contact lens management for ECDs. Contact lenses play a crucial role in visual correction and can be highly customized to address the unique challenges posed by corneal ectasias. Various types of contact lenses are available, including corneal, scleral, hybrid, piggyback, soft disposable, and soft customized lenses, each with its advantages and considerations. These lenses can be customized to better align with the ocular surface and effectively manage high-order aberrations (HOAs). Recent advancements have led to the development of management flowcharts,[16,17] which aid in selecting the most appropriate treatment[16] and contact lenses[17] for each type of corneal ectasia. An innovative approach considers the characteristics of different ectasias and provides a systematic framework for prescribing lenses, reducing trial-and-error, and optimizing patient care (Figure 2).[17] Additionally, new technologies and algorithms are being developed to further enhance decision-making processes, minimizing the number of trial lenses and clinic visits required to find the best management strategy for individual patients.

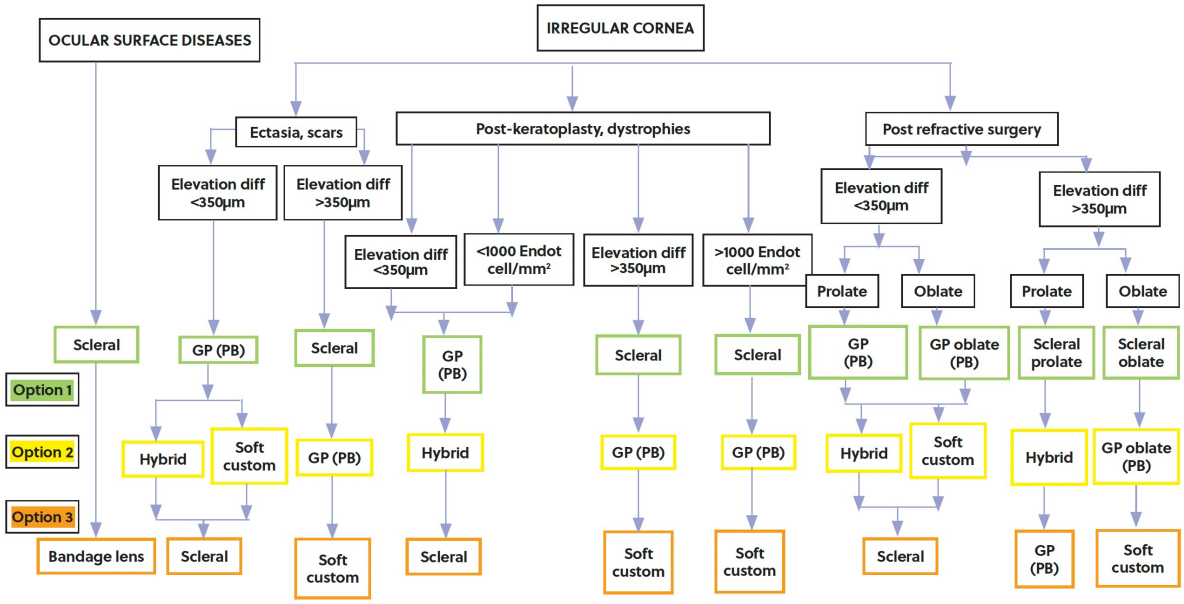

Figure 2: Contact lens flowchart for lens selection in ocular surface diseases and irregular corneas. GP: Gas permeable; PB: piggyback system. This figure was created by and originally published in Optometry Today in June 2022. from: Michaud L, Fadel D. Scleral Lens Fitting: Where Should We Start?[17] Figure is copyright of Optometry Today.

Corneal crosslinking (CXL) should be considered as the initial treatment for pediatric patients diagnosed with KC to prevent disease progression. Prompt diagnosis, monitoring,[16] and patient education about avoiding eye rubbing are crucial for successful outcomes with CXL.[18] Refractive surgery techniques, including corneal or intraocular procedures, may be options for stable ectasis, while corneal transplantation and implantations are indicated in advanced KC.[16]

Optical Management

Spectacles

In cases of mild ectasias, spectacles may be considered as a potential solution. However, they often fail to offer adequate visual correction.[14] To address this issue, a novel design has been introduced, which takes into consideration the non-orthogonal positions of the eye's two optical power meridians. This particular design has demonstrated the ability to improve best-corrected spectacle acuity by 1-4 lines in two individuals with mild KC (refractive astigmatism ≤ 2.50 D).[19]

Non-customized Soft Contact Lenses

Non-customized soft contact lenses are a viable option for mild ectasias, decentered cones, and patients who are intolerant to rigid lenses.[20,21] These lenses, available in high spherical and toric powers, can correct myopia and astigmatism.

Soft Customized Contact Lenses

Soft customized contact lenses, made of hydrogel or silicone hydrogel materials, can be personalized with specific sagittal depths, diameters, and power to address irregular astigmatism and improve vision correction. Customizable thicknesses can also mask astigmatism and enhance visual acuity.[22] Additionally, wavefront optics with soft lenses can correct residual aberrations, further improving visual outcomes.[22] These lenses improved visual acuity and quality of life compared to rigid corneal lenses.[23]

Corneal Lenses

Corneal lenses, such as multi-curve and quadrant-specific designs, are commonly used in managing corneal irregularities. These lenses act as a mold for the tear film layer, compensating for anterior corneal irregular astigmatism and improving visual quality.[24] Corneal lenses require careful fitting techniques, such as apical clearance, three-point touch, or apical touch, to ensure optimal lens fits and minimize corneal scarring.[25-27]

Piggyback Contact Lens System

The piggyback contact lens system, involving the use of a corneal lens on top of a soft contact lens, is recommended when corneal lenses are unstable or cause discomfort, staining, and corneal scars.[28-31] This system provides stability and comfort while improving visual outcomes.

Hybrid Lenses

Hybrid lenses, which combine the advantages of corneal and soft lenses, offer improved comfort and vision correction, making them suitable for individuals with unstable corneas or reduced lens tolerance. In a retrospective study, SynergEyes hybrid lenses were successfully fitted in 87% of patients after approximately eight months of follow-up.[32] While a comparative study found no significant difference in visual acuity between hybrid and rigid lenses, those using hybrid lenses reported higher overall satisfaction and better vision-related quality of life.[33]

Corneoscleral Lenses

Corneoscleral lenses improve vision and comfort in corneal ectasias. They fit well and center properly due to customization options. They have less movement on blinking than rigid corneal lenses, but more movement than scleral lenses.[34] This mild movement promotes oxygen delivery, prevents corneal edema, and allows tear exchange.[35,36] However, limbal compression should be avoided to prevent neovascularization.[37]

Scleral Lenses

Scleral lenses, which vault the entire cornea and rest on the conjunctiva, have become increasingly popular for managing advanced ectasias (Figure 3). These lenses provide stability and improve visual outcomes by compensating for corneal irregularities.[38] They have become a preferred choice for many eye care practitioners.[39] Scleral lenses are available in various designs, including prolate and oblate back optic zones, and can be customized based on scleral profilometry or impression techniques. They offer a stable platform for adjusting the lens design to enhance fit, centration, and visual quality with HOA management.

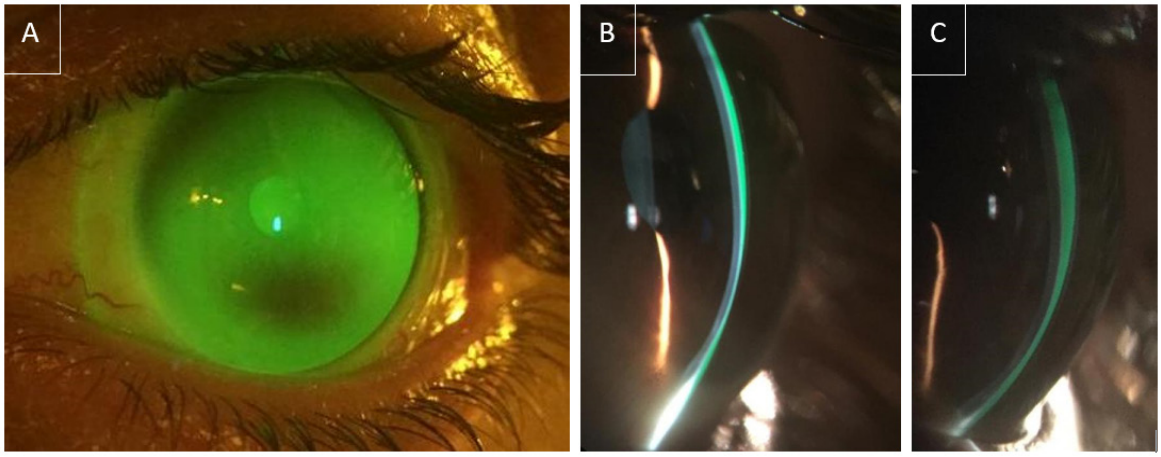

Figure 3: These images delineate the application of a scleral lens on an eye with advanced decentered ectasia. In all the images, the post-lens fluid reservoir is stained with fluorescein. Utilizing a diffuse illumination technique with cobalt blue light and a Wratten filter, a dark area is visible in the mid-peripheral cornea, indicating the lens touching over the corneal apex (A). An optic section observation showing the difference in the fluid reservoir thickness between the inferior and superior corneal areas, indicating a low clearance in the inferior corneal area, while excessive clearance is observed in the opposite quadrant (B). To prevent lens contact over the ectasia, the corneal clearance was increased, resulting in further clearance in the opposite quadrant (C). A customized scleral lens in the corneal area would be beneficial in addressing the significant difference in corneal clearance.

Surgical Treatments

Corneal Crosslinking

CXL has emerged as a breakthrough treatment for KC progression. By strengthening the cornea through the formation of chemical bonds between collagen fibrils, CXL has shown effective results in halting the progression of KC[40] and stabilizing corneal topography.[41] A Cochrane study on CXL for KC also demonstrated positive outcomes, as the procedure enhanced corneal strength and yielded improvements in visual outcomes. However, due to the limited sample size and methodological concerns of the studies examined, it remains challenging to ascertain the precise extent of the treatment's efficacy.[42] Prompt diagnosis and monitoring are crucial for successful outcomes, and early intervention with CXL has been shown to yield better results.[43,44] While transepithelial (epi-on) CXL methods are gaining popularity, conventional epithelium-off CXL has shown better overall outcomes, particularly in terms of regularizing the corneal surface and improving HOAs.[45] However, caution should be exercised in patients with corneas below a certain thickness to avoid potential toxic reactions in the corneal endothelium.[46,47]

Refractive Surgery

Refractive surgery interventions, such as customized advanced surface ablation photorefractive keratectomy (PRK),[48] intracorneal ring segments (ICRS),[49] and toric intraocular lens implantation (IOL),[50] offer viable options for improving visual acuity and reducing HOAs in select cases of stable KC. These procedures can be used in combination, providing relative success when tailored to each patient's specific needs.[16] However, it is important to note that these interventions are typically reserved for cases where contact lenses are no longer effective.[16,50] Combining PRK and ICRS with CXL has shown positive results, indicating potential synergistic effects.[51]

Corneal Transplantation and Implantation

For cases where contact lenses and refractive surgeries are insufficient, corneal transplantation remains the standard treatment choice.[16] While traditional penetrating keratoplasty (PK) has been the primary surgical approach, the emergence of deep lamellar keratoplasty (DALK) in recent years offers a less invasive alternative. This innovative technique preserves the posterior limiting lamina and endothelium, minimizing the risk of graft rejection and endothelial cell loss associated with PK.[52,53]

New techniques, like anterior limiting lamina transplantation and intrastromal stem cell implantation, show promise in stabilizing progressive ectatic corneal changes in advanced KC.[16] By maintaining stable vision with contact lenses, these techniques may delay or prevent the need for invasive corneal transplants like PK or DALK.[54]

Pediatric KC

In pediatric patients, KC presents unique challenges due to its accelerated progression,[55] advanced disease stage at diagnosis,[55] and potential co-existing medical conditions.[56,57] Early diagnosis, close monitoring, and timely intervention with collagen crosslinking are crucial to prevent further deterioration in visual acuity and ensure optimal outcomes. Although evidence is limited, corneal CXL has shown promise in stabilizing KC in a 4-year-old child with Down syndrome, emphasizing the importance of appropriate patient selection and follow-up care.[58]

Conclusion

Advancements in managing ECDs have led to a wide range of contact lens options tailored to different disease stages. Personalized fitting and customized options like scleral lenses improve visual acuity and manage HOAs. Guidelines aid practitioners in selecting suitable lenses, considering individual needs. CXL is the primary treatment for progressive KC, while refractive surgeries and transplantation techniques provide alternatives. Timely diagnosis, monitoring, and patient education on eye rubbing are vital. Early intervention enhances outcomes for pediatric KC. A multidisciplinary approach and staying updated enable better visual outcomes and improved quality of life for ECD patients.

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