Acta Scientific Ophthalmology (ISSN: 2582-3191)

Volume 5 Issue 4 April 2022

Review Article

Orthokeratology for Myopia Control

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Received: January 15, 2022

Published: March 04, 2022

Abstract

Purpose: Orthokeratology is a technique of temporarily correcting myopia and slowing its progression by gently flattening the central cornea [7-9]. The goal of this article is to analyze the Ortho-k evolution, parameters selection, designs, and fitting of ortho-k lenses, the role of Ortho-k as well as its influence on the corneal surface, to temporarily correct myopia and slow its advancement.

Keywords: Orthokeratology; Corneal Refractive Therapy (CRT); Vision Shaping Treatment (VST)

Introduction

Orthokeratology (ortho-k), commonly known as corneal refractive therapy (CRT) or Corneal reshaping or Vision Shaping Treatment (VST) is a non-invasive and non-surgical method that involves overnight wear of specially designed rigid contact lenses that can temporarily correct myopia and slow its progression by gently flattening the central cornea [7-12].

History

In the 1960s, Jessen [1] created the first Ortho-K lenses made of a polymethyl methacrylate, a rigid substance that limits oxygen passage through the lens, preventing Ortho-K from becoming a widespread treatment. With the introduction of rigid flat-fitting contact lenses in the 1970s, orthokeratology was reintroduced. These lenses could only reduce myopia by around 1 D and were ineffective at enabling oxygen to pass through the lens, making Ortho-K a novelty [6]. Rigid GP lenses were developed in the late 1970s utilizing new plastic materials that allowed more oxygen into the cornea, improving comfort and safety [2,3]. Nick Stoyan and Wlodyga created the first reverse geometry lens with a secondary curve of a steeper slope than the base curve in 1989 [4,5]. In 1998 [4], Contex Inc. (Sherman Oaks, CA) received FDA certification for a daily-wear Ortho-K design. In 2002[34], the FDA approved an overnight Ortho-K design by Paragon Vision Sciences that included all age groups and corrections up to -6 D.

How does ortho-K work

Hyperopic defocus, which leads to hyperopic retinal blur at the peripheral retina, can occur in children with a significant lag of accommodation during excessive close activity. This is more frequent in myopic children. The beam of light that focuses posterior to the peripheral retina might be a signal for total axial length elongation, which leads to myopia development. Peripheral refraction, which is not affected by central vision, may have an impact on eye growth [15,16]. Myopic eyes display relative hyperopia in the periphery that hyperopic and emmetropic eyes do not, and children with myopia have higher relative hyperopic peripheral defocus two years before the onset of myopia than emmetropic children. The central cornea is flattened using ortho-k lenses, resulting in an oblate shape. The image is focused centrally at the fovea at the juncture where the oblate portion of the cornea returns to its original curvature, whereas peripheral light focuses anterior to the peripheral retina, resulting in a peripheral refractive state that shifts from relative hyperopic defocus to relative myopic defocus, thus optically correcting myopia and controlling its progression. Ortho-K also helped children with their accommodation and convergence [8]. When compared to single vision gas permeable contact lenses, soft contact lenses [32], and single-vision spectacles, Ortho-k lenses slow axial length growth [26-30]. As a result, Ortho-k has a corrective as well as a preventive/control impact in childhood myopia [21-24].

Ideal patients for Ortho-K

- Myopia with Spherical refractive power ranges from -1.00 D to -5.00 D, Cylindrical power of 1.50 D or less "with-the-rule" corneal astigmatism - 0.75 D or less "against-the-rule" astigmatism
- Pupil diameter less than ~6.00 mm in dim illumination.
- Soft lens wearers who suffer from lens -related discomfort or dryness and allergies.
- Free of corneal dystrophies (such as keratoconus), ocular diseases, or any other condition that would prevent the patient from wearing a GP lens.
- Children that are beginning to be nearsighted.
- Those who are active in sports and activities like swimming.
- Those who don't want to wear glasses or contact lenses during the day.
- Those who are too young for Lasik yet desire a non-surgical alternative to surgery.
- Highly motivated to learn how to put and remove contact lenses, as well as to use and care for their lenses as instructed.
- Determined to compensate the initial and continuing costs of ortho-k therapy.

Fitting of Ortho-K

Pre-Fitting Examination includes:

- Cycloplegic Refraction
- Keratometry Readings
- Corneal topography (Eccentricity)
- Tear film analysis
- Biomicroscopy
- HVID
- Pupil diameter (photopic, mesopic, and scotopic)
- Base on topographical data of the cornea and the subjective refraction, keratometry reading, an initial shaping lens is chosen. Some manufacturing companies of ortho-k use a nomogram or computer design software. The initial shaping lens should be evaluated 10 to 30 minutes after lens insertion so that reflex tearing may subside.
- The Ortho-k lens parameters of the trial lens, is selected on the following criteria.

Base curve

The base curve of the first lens is fitted flatter than k- reading and alignment curves. The correction constant is an additional amount of flattening that is figured into the Base Curve to overcome a slight amount of initial rebound of the cornea when the lens is first removed. The correction constant is typically 0.75 diopters. PAR refers to posterior apical radius measured in mm, is calculated by: PAR = (337.5/(Flat K + Target Correction-Correction Constant)).

E;g K1= 45D, K2= 42D, Target correction of -3.00 D,

BC= (337.5/(42.00D + (-3.00) - 0.75)= 337.5/38.25 = 8.8 mm

Lens diameter

- Lens diameters between 9.8 mm to 11.5 mm are chosen to maximize centering to the cornea and to minimize lens movement. Lens diameters outside of this range are occasionally used for some eyes.
- Determining Starting Lens Diameter: If K is 41.00 and flatter use 10.6 mm diameter, 41.25 to 45.25 use 10.0 mm diameter, 45.50 and steeper use 9.8 mm.

Initial lens power selection

Standard procedures for determining the power of rigid gas permeable contact lenses may be used, including compensation for vertex distance.

Ortho-k lens design and fitting

Modern ortho-k are made with highly oxygen permeable rigid materials and utilises reverse geometry lens designs, consist of four or five zones [13].

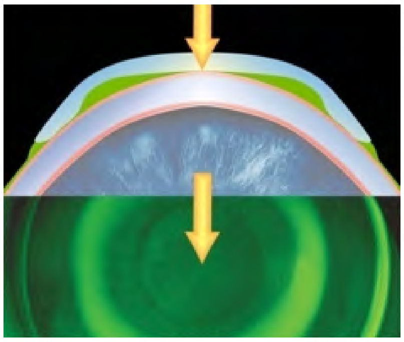

Figure 1: Base curve/Back optic zone radius: Fitting flatter than the central corneal resulted in the appearance of central bearing.
Source: Euclid certification module 2
(https://euclidsys.com/modules/fundamentals/).

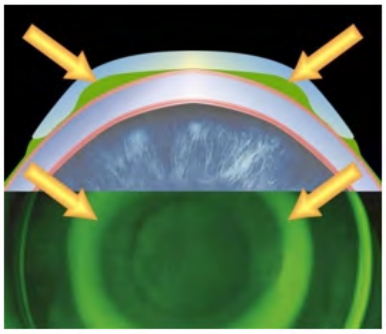

Figure 2: Reverse curve: fitting steeper than the back optic zone radius resulted in sodium fluorescein pooling.
Source: Euclid certification module 2
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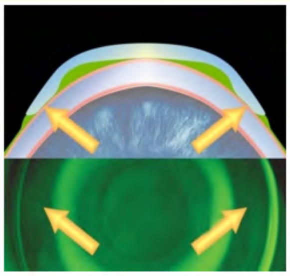

Figure 3: Two alignment curves (Zone 1 and 2): zone 2 to be fitted flatter than zone 1 to promote corneal flattening toward the periphery and thus give appropriate lens centration.
Source: Euclid certification module 2.
(https://euclidsys.com/modules/fundamentals/).

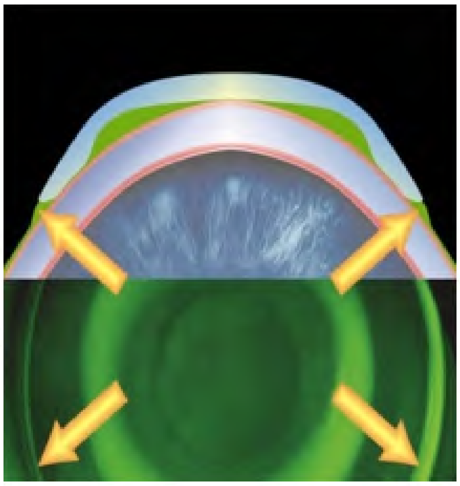

Figure 4: Peripherl curve: fitted flatter to provide edge lift.
Source: Euclid certification module 2.
(https://euclidsys.com/modules/fundamentals/).

Ortho-k lens evaluation

	Idea fitting	Steep fitting	Flat fitting
Movement	Well-centered superior vertically and or inferior	Well-centered or inferior	Usually superior, may also be inferior.
Central alignment zone:	3-5 mm	< 3-5 mm	> 3 mm
Reverse curve zone	Wide but tapered approximately 50 µm	Deep bubbles in reverse zone	wide
Mid-peripheral curve	Alignment (uniform) fluorescein 360°	Wide heavy bearing 360°	Reduce or absent
Periphery	axial edge lift approx. 0.70 µm axial	< 0.70 µm edge lift	> 0.70 µm axial edge lift
Movement	0.5-1.0 mm	< 0.5 mm	> 2.0 mm

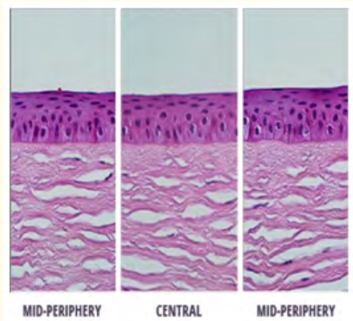

Figure 5: Morphology of epithelial cell before Ortho-k treatment.
Source: Euclid certification module 2.
(https://euclidsys.com/modules/fundamentals/).

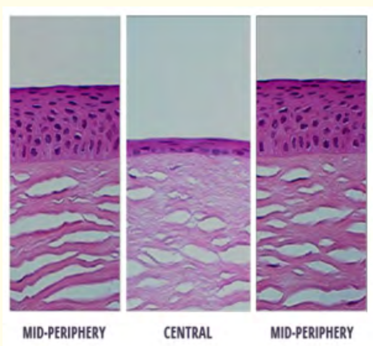

Figure 6: Morphology of epithelial cell after. Ortho-k treatment.
Source: Euclid certification module 2.
(https://euclidsys.com/modules/fundamentals/).

Morphological changes in corneal epithelial cell after Orthokeratology

Orthokeratology causes reversible structural changes in the corneal epithelial cells while the depth of the anterior chamber or the shape of the posterior corneal surface is unaffected [17,18]. Corneal changes induced by orthokeratology could be explained by redistribution or remodeling of anterior corneal tissue, rather than an overall bending of the cornea [41]. The central thinning was found to be primarily epithelial in origin, whereas the mid-peripheral thickening included a significant stromal component [41]. The epithelium cells of the central cornea are compressed and flattened by a positive force (push), whereas the reverse zone is subjected to a negative force (pull), resulting in larger and more oval mid-peripheral epithelial cells. This caused fluid to move from the center to the mid-periphery regions of the cornea. The central corneal thickness reduced due to epithelial thinning, while the mid-peripheral cornea thickened due to epithelial and stromal alterations. Hydraulic forces in the post-lens tear film induce tangential stresses across the corneal epithelial surface, resulting in anterior corneal shape and thickness alterations [33].

Discussion

The prevalence of myopia is increasing worldwide [34-37] and younger generations are affected more than others [33-35]. Early initiation of ortho-k treatment may be possible to reduce the prevalence of high myopia in younger myopic children. It necessitates specialized training, equipment, and skills. Cleaning and disinfecting lenses and accessories, as well as maintenance instructions, should assist to lower the incidence of complications such as corneal abrasion, microbial keratitis, etc. More recent advancements in Ortho-k design, such as the MOONLENS orthokeratology and the REMlens orthokeratology, have led to improved myopia control. In the future, more research on peripheral refraction will be needed to determine why some people did not progress as quickly as others. The use of Ortho-k kens as myopia management techniques is being investigated in order to permanently reduce the risk of myopia onset. More research is needed to address these essential concerns so that we may enhance child eye care and possibly prevent or maintain lower myopia levels, reducing the risk of sight-threatening diseases.

Conclusion

Hence we could conclude that Orthokeratology is safe and effective form of optical correction that has the added benefit of controlling myopia in children, providing excellent vision and improve vision-related quality of life, hence becoming increasingly popular. It may be possible to lower the prevalence of high myopia in younger myopic children by initiating ortho-k therapy early.

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