Benefits, clinical facts and potential complications associated with overnight Orthokeratology

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Abstract: Orthokeratology, also known as corneal reshaping, is a clinical technique designed to alter corneal shape, and in terms providing a temporary correction of myopic refractive error. Although there is no direct evidences showing that orthokeratology itself can halt or even reverse the progression of myopia, there are studies indicated that the procedure can suppress axial length elongation in childhood myopia. Despite its low incidence rate, microbial keratitis is a potential complication of overnight orthokeratology that may cause significant visual impairment. In this article, we will focus on the benefits, clinical facts and potential complication such as infectious keratitis associated with orthokeratology.

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1. Introduction

Myopia is one of the most common ocular conditions in humans, affecting 25% of the United States population between the ages of 12 and 54 years.[1] The prevalence of myopia varies in different regions of the world, being higher in Asians (38.7%) than in Caucasians (17%).[2,3] In the adult Hong Kong Chinese population, prevalence of myopia is as high as 71%.[4] It is a fact that the earlier the patient diagnosed as myopic, the higher chance he or she will have more severe myopic side effects later in life and these include retinal detachment, macular degeneration, glaucoma, and ultimately blindness. The associated risk of these complications developing increases with the severity of myopia and axial length.[5] The World Health Organization identified myopia as one of the five leading causes of blindness and visual impairments in the world.[6] Progression of youth-onset myopia is attributed widely to axial length elongation, which cannot be compensated by reductions in the corneal and crystalline lens power; however, the detailed mechanisms involved in the etiology of myopia remain unclear.[7]

Orthokeratology has gain popularity, with predictable results of reverse geometry lens, patients only have to wear the lenses at night during sleep and able to see clearly without aids after removal on awakening, and continue to have relatively clear vision at the daytime. In addition, there are hypotheses suggesting the possibility of orthokeratology retarding myopia progression. We will discuss several clinical facts of orthokeratology and hopefully allow readers to better understand the mechanism behind it. Microbial keratitis is the most severe, adverse response associated with orthokeratology contact lens wear. In this article we will also discuss orthokeratology related infectious keratitis and to discuss the potential reasons causing it.

2. Material and Methods

Best corrected visual acuity was done by using Topcon phoroptor. Documenting ectatic condition was done by Dicon topographer (Paradigm Medical, USA) and keratometry reading via Topcon keratometer. Corneal pachymetry performed by Orbscan II. Contact lenses used are Dreimlens Orthokeratology lens, Euclid Orthokeratology lens, and Paragon (CRT) Orthokeratology lens.

3. Results and Discussion

The reverse geometry of orthokeratology contact lens has a flat central curvature with a steep secondary curve. (Fig. 1 and 2) The flat central area exerts a positive pressure on the cornea and induces flattening. These lenses are advised to be worn during sleep and allow the patient to achieve improved uncorrected visual acuity during the daytime.

The followings are the clinical facts and hypotheses of overnight orthokeratology generally accepted by Eye care practitioners today.

1. Acceptable vision without aids at daytime: As the designed reverse geometry lenses are worn, the cornea is reshaped, and the predicted amount of myopia is reduced as the patient sleeps. After removal of the lenses upon wakening, relatively good

vision is maintained without any optical aids during the daytime.

2. Suppression of axial length elongation in childhood myopia: In 2005, Cho et al. reported that axial length in children increased over a 2-year period by 0.29 ±0.27 mm in an OK treated group and by 0.54 ±0.27 mm in a control group treated with spectacles.[8] In 2009, Walline et al. reported similar findings, whereby the mean increase in axial length after 2 years was 0.25 mm in the OK group and 0.57 mm in the control group.[9]Sinceprogression of youth-onset myopia is attributed widely to axial length elongation, this may imply the use of orthokeratology may slow down the progression of myopia in children.

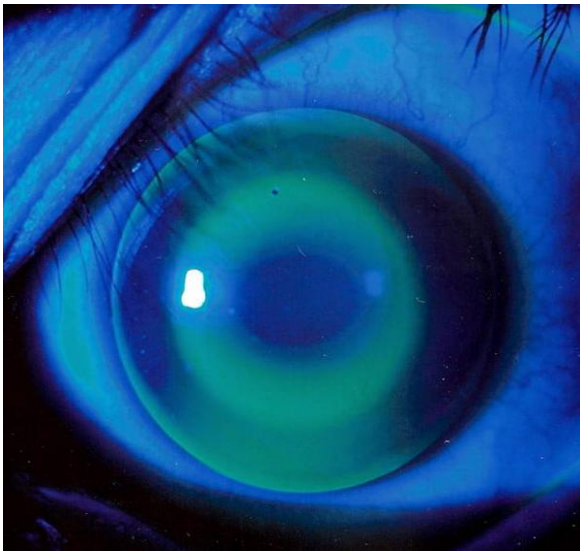

Fig. 1. Spherical orthokeratology lens fitted on a cornea with high astigmatism.

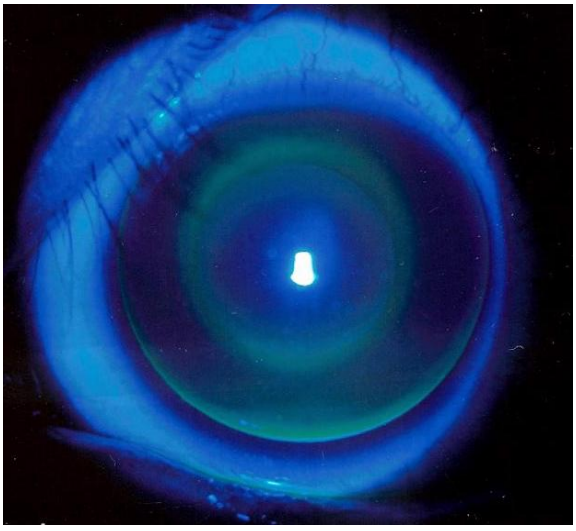

Fig. 2. Spherical orthokeratology lens fitted on a cornea with mild astigmatism.

3. Less effective in slowing axial elongation in lower degree of myopia: It has been reported in a previous study that OK is less effective in slowing axial elongation in low compared to higher degrees of myopia.This may be a good hypothesis because it means that with orthokeratology, the axial length of higher degree of myopic patient would elongate less than that of lower myopic patients in the same amount of time.

4. Creating myopic defocus in the periphery in myopic children may provide a potential mechanism for myopia control: There are studies showing that inducing hyperopic defocus on the peripheral retina promoted the development of central axial myopia in infant monkey. [10]Therefore, by converting peripheral hyperopia measured at baseline to relative peripheral myopia, one would expect less central axial elongation in myopic children with orthokeratology lenses. This hypothesis suggests that the earlier the orthokeratology lens been worn, the better retardation on axial length elongation.

5. Corneal epithelium is the principal structure affected by the mechanical forces exerted by the OK lens: Central corneal epithelium undergoing significant cell shape and size alteration in response to orthokeratology contact lens. On the other hand, no much change happened on the cells of corneal endothelium or stroma. Total peripheral corneal thickness is hence increased in comparing to that of baseline values.

6. Superior inhibitory effect on axial length elongation: The inhibitory effect of OK on axial length elongation was superior to that of progressive addition lenses wearing and topical administration of pirenzepine ophthalmic gel.[11]

All of these studies and findings demonstrateda clinical benefit of orthokeratology in retarding axial growth in myopic children.

Although the risk of infection with overnight orthokeratologyis rarely reported, this complication can be devastating and potentially vision-threatening. Besides, it is likely that many cases of infection are not reported. The availability of high-DK materials for rigid gas-permeable contact lenses and reverse-geometry design has not completely eliminated infectious keratitis as a complication of

orthokeratology. There are many risk factors for microbial keratitis (Fig.3, 4 and 5) associated with orthokeratology contact lens, and they include overnight lens wear, prolonged corneal hypoxia, and poor patient compliance with lens(Fig. 6) and lens case hygiene.[12] It has been known that overnight wear is the most important risk factor for infectious keratitis among all types of contact lens users. Several studies have shown that overnight contact lens wear, including wear of high oxygen

transmissibility RGP lenses, impairs theepithelial barrier because of the reduced oxygen transmissionthrough contact lens. In addition, lack of eye movements thathelp disrupt the bacterial glycocalyx and spreads lysozymeover the corneal surface can render the eye more susceptible tobacterial infection.[13]

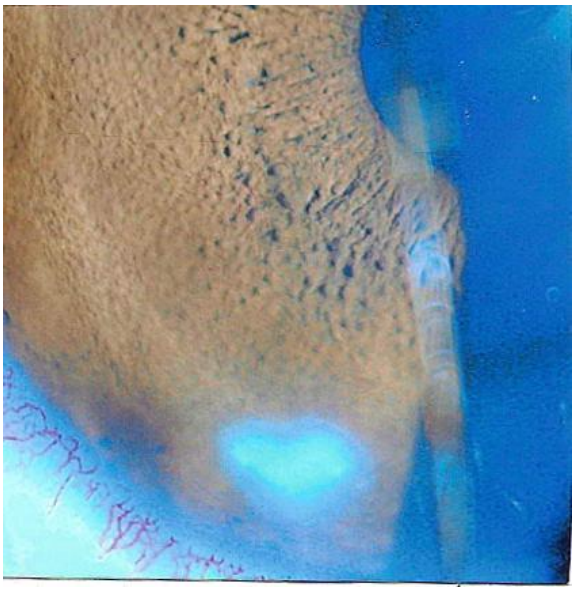

Fig. 3. Microbial keratitis ulcer at inferior peripheral cornea.

Fig 4: Microbial keratitis ulcers at central cornea.

Many species of microorganism have been cultured and identified from the Overnight orthokeratology infectious keratitis, and they include Pseudomonas aeruginosa , Staphylococcus species , Serratia marcescens, andAcathamoeba species. Pseudomonas aeruginosa is the most frequently isolated pathogen, because it is known to be the most common pathogen of contact lens–related corneal ulcers. In view of the high prevalence of *Acanthamoeba* keratitis reported, indicating the importance of eliminating the use of tap water in care regimens for overnight orthokeratology. Most of the infected patients responded well to treatment with antimicrobial medication, but often recovered with worsen corrected visual acuity range from 20/20~20/100 depends on the location of ulcer, severity of infection, and any delay in seeking urgent ophthalmic care. With recent raised popularity of orthokeratology, eye practitioners including optometrists and ophthalmologists, should be more careful in monitoring patients wearing theses lenses and to take extra step in educating both the parents and patients the importance of keeping proper contact lens hygiene.

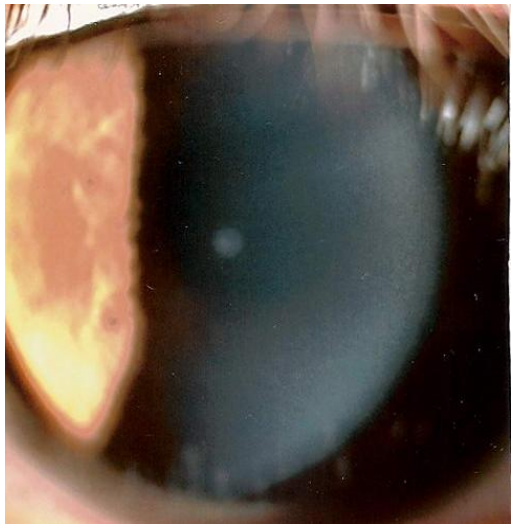

Fig. 5. Asmall central microbial keratitis ulcer.

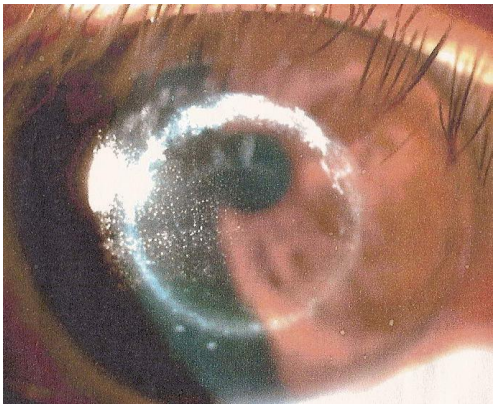

Fig 6: Heavy deposit at reverse curve on an orthokeratology lens.

4. Conclusion

Although the detailed mechanisms of myopia remain unclear, orthokeratololgy's effectiveness in slowing axial elongation may suggest its capability in retardation of myopia progression. In view of benefits and risks of orthokeratology, it is important to make sure both the parents and the wearers understand the pros and cons of the treatment, especially the potential complication of infectious keratitis associated with it. Patients wearing orthokeratology lenses should be instructed to remove their lenses and seek immediate medical treatment, if any symptoms of eye discomfort should occur.

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