

Wavefront analysis in orthokeratology corneal reshaping - A case report

角膜塑型術使用者之前導波分析一病例報告



敦南諾貝爾眼科
Dunnan Nobel Eye Clinic

趙振程 Chen-Cheng Chao, 張朝凱 Chao-Kai Chang

Introduction

Overnight orthokeratology (OOK) uses a particular rigid contact lens design and fit that induces a redistribution of corneal thickness (affecting mainly the epithelium), thus reshaping the corneal contour and temporarily reducing myopia. Previous scientific literature imply that OOK lens cause an increase in higher-order aberrations (HOAs), implying a reduction in the optical quality of the cornea that might provoke a decrease in visual quality.(1)

We want to report 2 cases with overnight orthokeratology lens wear and using wavefront aberrometry for evaluating changes of wavefront aberrations before and after OOK lens wear.

Method

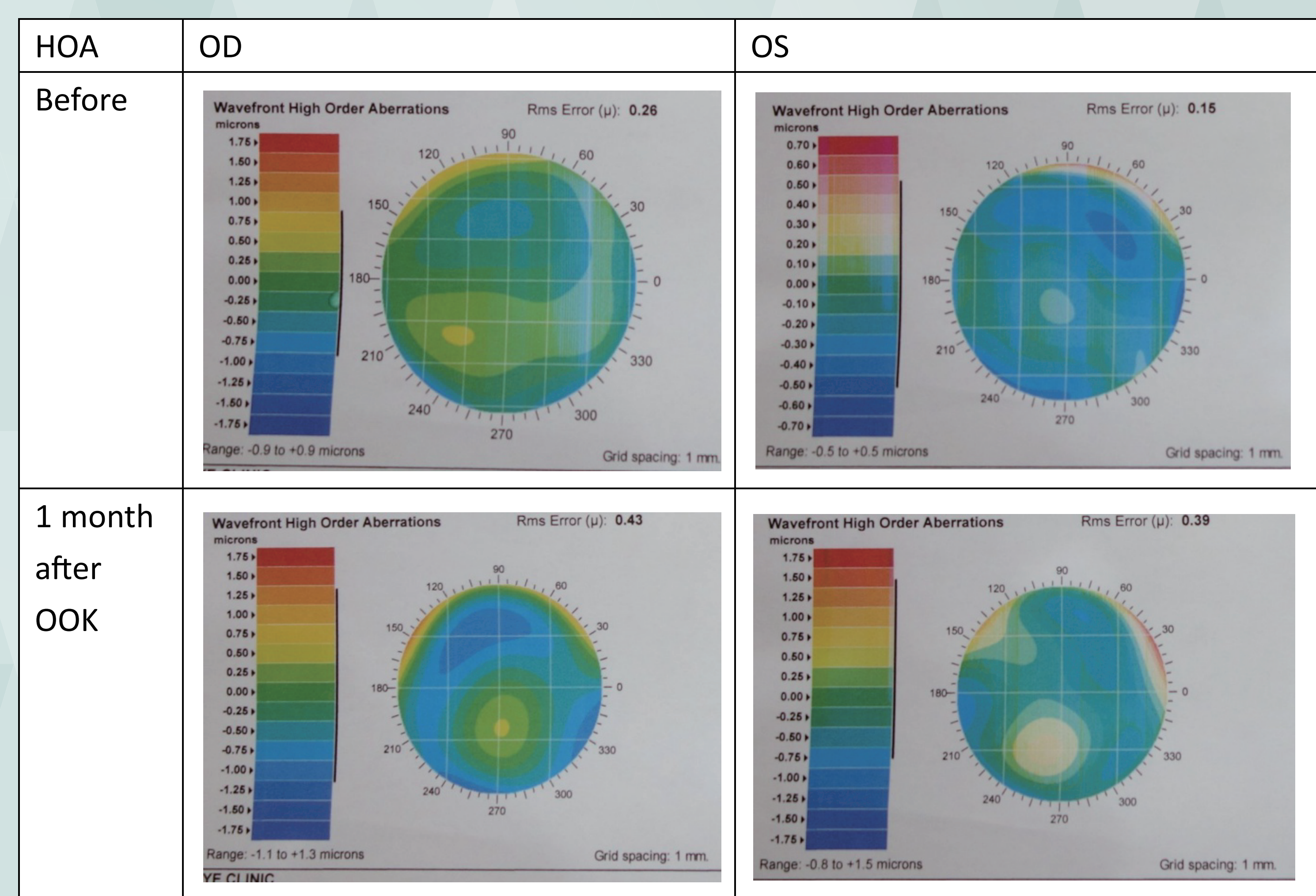
School-aged children were fitted with the OOK lens using computerized assisted fitting. Entry criteria include: 1) Age between 6-11 years old 2) Refractive errors with cycloplegic autorefraction, myopia within 0.50-4.00 diopter 3) Best corrected visual acuity no worse than logMAR 0.1. DreamLens (Hanita Lenses Investments, Hanita, Israel) shaping lenses were determined by previously fitted with trial lens set. At the delivery visit, fluorescein pattern of each lens on the eye was examined again.

Patients were required to wear the lenses every night for at least eight hours. They were followed-up in our clinic after the one day, one week and one month of lens wear. Refraction, corneal topography, visual acuity and external ocular health assessment were performed at each of these visits. The lens performance was reviewed at the one-month visit and refit was indicated only if lens decentration persisted or if there is residual myopia for more than 0.50 dipoter. Cease lens wear would be suggested if intolerable allergic conjunctivitis or >grade 3 corneal staining were noted. Artificial tear, sulfonamide eye drop and contact lens solution were provided for lens care. Antihistamine eye drop was prescribed if allergic conjunctivitis was noted.

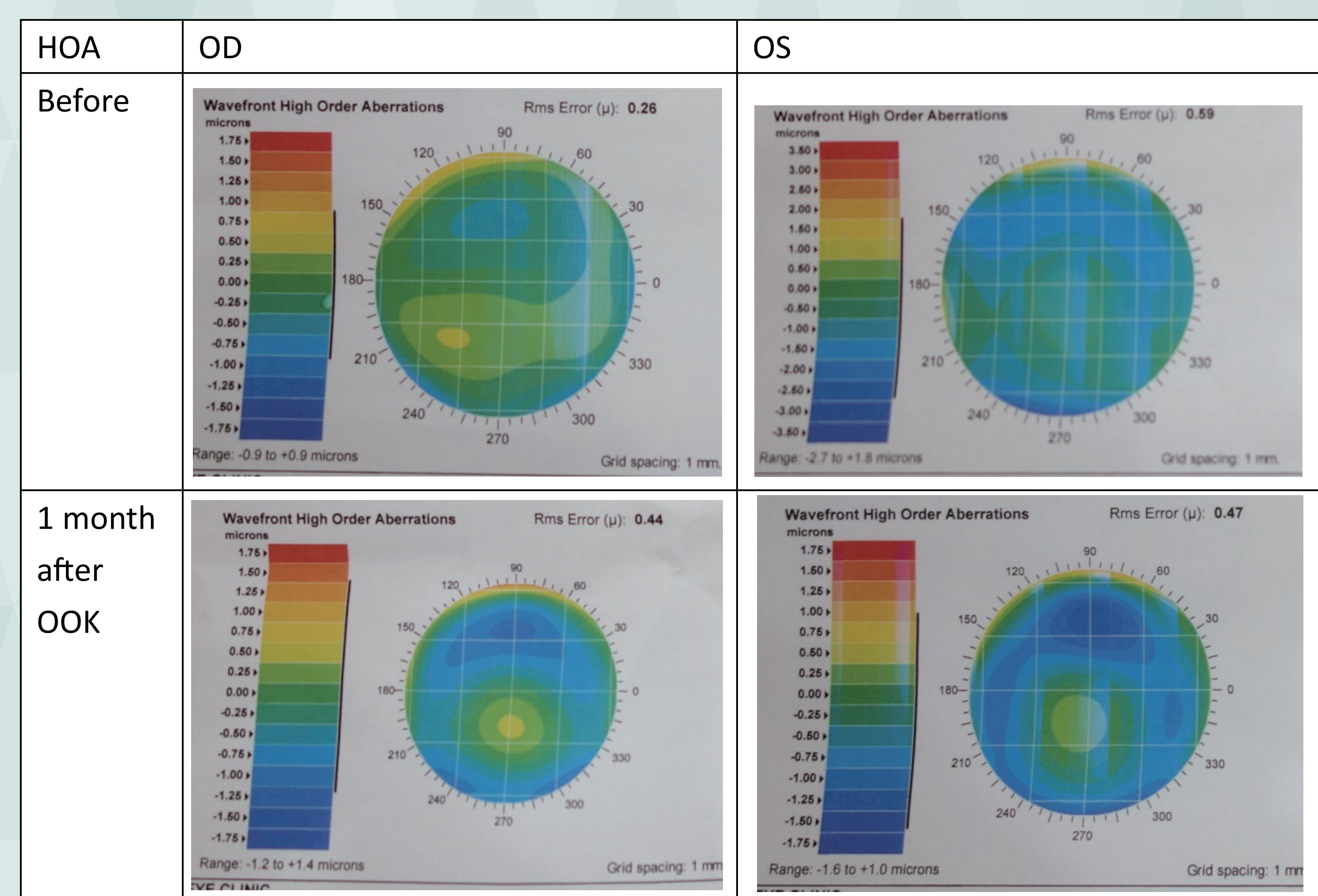
Wavefront aberrometry before and after OOK lens wear were using Visx Wavescan® aberrometer. Visx Wavescan measures the refractive error and wavefront aberrations of the human eye using a Hartmann-Shack wavefront principle. A small spot of laser light at 785 nm is projected onto the retina and reflects back through the pupil. The WaveScan system can measure spherical refractive errors between -12.0 D and +9.0 D, cylindrical refractive errors up to 5.0 D, and higher-order aberrations up to sixth-order. The WaveScan Fourier wavefront system is capable of reconstructing very complex three-dimensional surfaces with little processing power compared to ernike expansion. The algorithm provides the ability of peripheral data r representation using a multi term polynomial, which means it captures wavefront information in patients with larger pupils with highly aberrated optics and can treat higher and lower aberrations up to 7-mm diameter pupil (2)

Results

Case 1 was a 12 years old girl with her best corrected visual acuity was OD: -3.75-3.00x175/1.0, OS: -3.75-3.00x175/1.0, Cornea K was 42.12/46.37 in the right eye and 42.00/46.87 in the left eye. After one month of lens wear, uncorrected visual acuity was 1.0/1.0. All order aberration – Log 50% with Effect of Blur (D) was 5.89/4.91 (OD) and 6.35/5.92 (OS) before and after OOK lens use. High order aberration –root-mean-square(RMS) Error (μm) was 0.26/0.43 (OD) and 0.15/0.39 (OS) before and after 1 month of OOK lens use.



Case 2 was a 15 years old girl with her best corrected visual acuity was OD:-3.25/1.0, OS: -3.00/1.0, Cornea K was 43.00/43.50 in the right eye and 42.75/43.50 in the left eye. Uncorrected visual acuity after 1 month was 1.0/1.0. All order aberration was 3.79/2.97 (D) (OD) and 3.98/3.35(D) (OS) before and after OOK lens use. High order aberration was 0.52/0.43 (μm) (OD) and 0.59/0.47 (μm) (OS).



All order aberration decreased in these 2 cases and high order aberration weren't apparently increased. HOA RMS before OOK use was $0.38\pm 0.20\mu\text{m}$ and $0.43\pm 0.03\mu\text{m}$, not significant increased. No night vision symptoms were noted in OOK patients.

Discussion

Previous literature have demonstrated that the increasing of higher-order wavefront aberration of eyes could reduce contrast sensitivity in patients receiving laser in situ keratomileusis (LASIK) (3). In a study comparing HOA between OOK and LASIK in low myopia patients, higher increase in HOAs produced by OOK compared with LASIK would justify the worse visual quality results obtained. (4) In Lian's series (1), corneal total HOA RMS from $0.30\pm 0.08\mu\text{m}$ at baseline to $0.99\pm 0.36\mu\text{m}$ at day 30 and ocular HOA RMS increased from $0.27\pm 0.12\mu\text{m}$ at baseline to $0.69\pm 0.21\mu\text{m}$ at day 30. In our cases of 4 eyes, HOA RMS before OOK use was $0.38\pm 0.20\mu\text{m}$ and $0.43\pm 0.03\mu\text{m}$, not significant increased compared with the study mentioned above. The reasons that caused HOA in OOK patients varied, we postulate that with the OOK lens more centered, the less HOA it may induced.

Reference

1. Lian Y, Shen M, Huang S, Yuan Y, Wang Y, Zhu D et al. Corneal reshaping and wavefront aberrations during overnight orthokeratology. Eye Contact Lens. 2014 May;40(3):161-8.
2. Knapp S, Awwad ST, Ghali C, McCulley JP. Ocular aberrations measured by the Fourier-based WaveScan and Zernike-based LADARWave Hartmann-Shack aberrometers. J Refract Surg 2009 Feb;25(2):201-9.
3. Yamane N, Miyata K, Samejima T, Hiraoka T, Kiuchi T, Okamoto F, et al. Ocular higher-order aberrations and contrast sensitivity after conventional laser in situ keratomileusis. Invest Ophthalmol Vis Sci. 2004 Nov;45(11):3986-90.
4. Madrid-Costa D, García-Lázaro S, Albarrán-Diego C, Ferrer-Blasco T, Montés-Micó R. Visual Quality Differences Between Orthokeratology and LASIK to Compensate Low-Moderate Myopia. Cornea. 2013 Aug;32(8):1137-41.